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Using Hierarchical Clustering and Association Mining Techniques to Plan a Supermarket Business and Market

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ABSTRACT: The economic potential of today's large corporations has not been fully realized since there are insufficient techniques for meaningful data extraction and translation. The new branch of calculating method known as "Data mining" is required in order Using a rigorous data analysis technique, extract important knowledge from a large-scale resource. The goal of this research is to utilize hierarchical clustering to depict the cluster of high-profit, high-standard, low-risk, high-focus, and low-care supermarket customers. In this approach, we think that our clustering method may contribute to improving the supermarket's business plan. Additionally, this paper illustrates how to position a product correctly based on a customer's frequent purchase behaviour. Making advantage of this will assist^{[1][2][3]}

What is a supermarket?

A supermarket is a big retail establishment that mostly offers food and home goods the general public. Supermarkets are designed to provide customers with a convenient and one-stop shopping experience. They typically carry a diverse range of items such as fresh

produce, meat, dairy products, canned and packaged goods, frozen foods, snacks, beverages, cleaning

supplies, personal care products, and sometimes even clothing and household items.

Supermarkets are organized into different sections or departments, allowing customers to easily navigate and find the products they need. These sections may include the bakery, deli, produce, meat and seafood, dairy, grocery aisles, and non-food items.

Supermarkets offer self-service shopping, where customers can browse the aisles, select

the items they want, and place them in a shopping cart or basket. They usually have a checkout area where customers pay for their items before leaving the store.

Supermarkets are known for their wide product selection, competitive pricing, and convenient operating hours. They are commonly found in urban and suburban areas, catering to the everyday needs of the local community.

what is data mining, and how it is used in supermarket?

The process of identifying patterns, correlations, and insights from massive amounts of data is known as data mining. It entails a variety of strategies and algorithms. to analyze data and discover meaningful information. In the context of a supermarket, data mining is used to analyze customer behavior, improve operational efficiency, and enhance decision-making processes. Here are some specific applications of data mining in supermarkets.

1.Customer Segmentation: Data mining techniques may be used to categories clients based on their shopping habits, demographics, or other pertinent factors. By identifying different customer groups, supermarkets can personalize their marketing strategies, tailor product offerings, and provide targeted promotions to enhance customer satisfaction and loyalty.

2. Market Basket Analysis: A data mining approach that finds market baskets relationships between two or more goods frequently purchased together. By analyzing transaction data, supermarkets can identify associations between products and use this information for strategic purposes, such as optimizing product placement, cross-selling, and upselling.

3.Demand Forecasting: Data mining can help supermarkets predict future demand for different products. By analyzing historical sales data, seasonal patterns, and other relevant factors, supermarkets can make accurate demand forecasts. This information is valuable for inventory management, ensuring adequate stock levels, reducing stockouts, and optimizing supply chain operations.

1. Recommender Systems: Data mining techniques can power recommender systems in supermarkets. These systems

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analyze customer choices, buying history, and behaviors are used to generate personalized suggestions. System of recommendations can be used on supermarket websites, mobile apps, or loyalty programs to suggest relevant products, leading to increased customer satisfaction and sales.

2. Fraud Detection: Data mining can assist in detecting fraudulent activities in supermarkets. By analyzing transactional data, anomalies can be identified, enabling supermarkets to detect and prevent activities such as fraudulent returns, coupon abuse, or suspicious transactions. This helps protect the supermarket's revenue and maintain a secure shopping environment for customers.

Overall, data mining in supermarkets enables better understanding of customer behavior, enhances operational efficiency, optimizes marketing strategies, and improves decision-making processes. By leveraging the power of data, supermarkets can gain a competitive advantage, increase customer satisfaction, and drive business growth^[13]

Why required data mining, and its benefits ?

- 1. Decision Making and Strategy Formulation: By analyzing historical data and identifying trends and patterns, data mining assists in making accurate predictions and informed decisions. It aids in formulating effective business strategies, optimizing processes, and achieving organizational goals.
- 2. Customer Understanding and Behavior Analysis: Data mining allows organizations to gain a deeper understanding of customer preferences, behavior, as well as requirements. Businesses may personalize their services by analyzing user data. their offerings, enhance client satisfaction and increase client loyalty.
- 3. Market Analysis and Forecasting: Data mining techniques help in analyzing market trends, identifying market segments, and predicting future market conditions. This information is crucial for businesses to adapt their strategies, identify new opportunities, and stay competitive in the market.
- 4. Fraud Detection and Risk Management: Data mining plays an important function in the identification of fraud and risk management. By examining trends and irregularities in financial transactions or insurance claims, organizations can identify fraudulent activities and mitigate risks effectively.
- 5. Knowledge Discovery: Data mining helps uncover patterns, relationships, and insights from large volumes of data. It enables organizations to extract valuable knowledge and make informed decisions based on data-driven evidence.
- 6. Product Development and Optimization: Data mining helps organizations understand customer preferences, market trends, and feedback to develop new products or optimize existing ones. It enables businesses to tailor their offerings to meet customer demands and achieve higher customer satisfaction.
- ^{7.} Predictive Maintenance: Data mining techniques can be applied to analyze sensor data from machinery and equipment to enable predictive maintenance. By identifying patterns and anomalies in the data, organizations can schedule maintenance activities proactively, minimize downtime, and reduce maintenance costs^{.[15]}

Clustering

The identification of similar item classes are characterised as clustering. Using clustering methods to discover sparse and dense areas in the realm of objects, we may detect overall distribution patterns and correlations among data features. Classification It can also be used distinguish yet it is not a collection or class of objects costly, thus clustering can be used as a pre-processing Method for selecting and classifying attribute subsets. As an example, classify genes with comparable functions and to create client groupings formed on the basis of purchasing habits. [2][12]

Hierarchical Clustering Process



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Association Rules

Discovering common item sets derived from a transaction dataset developing One of the most used data mining techniques is association rules. strategies. Frequently occurring

Combinatorial explosion of item sets (item sets with frequency more than or equal to a user chosen minimal supports) is seen noteworthy. when common sets of items are identified, It is simple to build association rules with confidence greater than or equal to a user-specified minimum confidence level. Apriori is an critical method for locating common itemset for both retailers and manufacturers. This analysed data might be used by a retailer to position goods that are commonly sold together in the same location. as a result of which shop goods sales grow. The Apriori approach was accustomed to identify Association rules. frequent item set's association rule has been produced. A Supermarket sales table dataset was utilised. The Apriori approach was used to produce a set of Association rules^[2]

A	ssociations					
				[Data Mining : Associations Rules	
ID	Name	Class ID	Category	٨	Category : Fruit	^
836 837 838 839 840 841 842 843 844 844	Party Nuts Lox Scalops Low Fat Cookies BBQ Potato Chips Com Chips Low Fat BBQ Chips Sugar Cookies Chocolate Chip Cookies Findre Conkies	1 24 2 45 12 12 12 45 45	Specialty Seatood Seatood Snack Foods Snack Foods Snack Foods Snack Foods Snack Foods Snack Foods Snack Foods		Items : 1-Ebony Cantelope 2-Ebony Honey Dew 3-Ebony Fuji Apples 4-Ebony Oranges 5-Ebony Tangerines Item Ebony Cantelope & Ebony Honey Dew are selected Item Ebony Cantelope & Ebony Fuji Apples are selected Item Ebony Cantelope & Ebony Oranges are selected Item Ebony Cantelope & Ebony Tangerines are selected Item Ebony Honey Dew & Ebony Tangerines are selected Item Ebony Fuji Apples & Ebony Tangerines are selected Item Ebony Fuji Apples & Ebony Tangerines are selected	

Results of associations

Market basket analysis is a popular and effective data analysis approach for marketing and commerce. Market's primary goal Basket analysis is used to determine which goods are often purchased together by the client. Customers' purchasing patterns are identified using market basket analysis. It raises awareness of a customer's 'basket' of items. The phrase 'basket' usually refers to a single order. However, the analysis may be applicable to different variants. Market Basket Analysis may assist you analyse the mix of items that will be sold together. Because of the enormous expansion and advancements in information technology, data can now be gathered considerably faster and in much bigger amounts. Scientists, engineers, and businesspeople require effective analytical approaches to deal with massive new information resources.

Extract usable information and discover new, valuable knowledge patterns. Association rule mining for supermarket datasets is described in this work. Mining has been used to dataset sales data. The apriori technique was employed on a supermarket dataset in the suggested system to provide associations of two goods with the highest support. ^[6]

Where we can apply data mining methods in supermarket ?

Data mining methods can be applied to various aspects of a supermarket's operations to gain insights and improve efficiency. Here are some specific areas where data mining techniques can be utilized in a supermarket:

1. Sales Analysis: Data mining can be used to analyse sales data to identify patterns, trends, and seasonality. This helps supermarkets understand customer preferences, optimize pricing strategies, and forecast demand accurately.

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It also enables them to identify the most profitable products, analyse sales performance by location or time period, and make data-driven decisions regarding inventory management.

- Customer Segmentation: By applying clustering algorithms, supermarkets can segment their customer base into distinct groups based on purchasing behaviour, demographics, or other relevant variables. This segmentation helps in understanding the needs and preferences of different customer segments, enabling personalized marketing strategies and targeted promotions.
- 3. Market Basket Analysis: is a widely used data mining method in supermarkets. It helps identify relationships between products that are frequently purchased together. This information is valuable for optimizing product placement, cross-selling, and upselling. Supermarkets can use the results of market basket analysis to strategically arrange products on shelves, create product bundles or promotions, and enhance the overall shopping experience.
- 4. Recommender Systems: Data mining can power recommender systems in supermarkets. By analysing customer purchase history, browsing behaviour, and demographic information, supermarkets can provide personalized product recommendations. Recommender systems can be implemented through supermarket websites, mobile apps, or loyalty programs, helping customers discover new products and increasing customer engagement.
- 5. Inventory Management: Data mining techniques can help supermarkets optimise inventory management. By analysing historical sales data, seasonal trends, and external factors such as promotions or weather conditions, supermarkets can accurately forecast demand and adjust their inventory levels accordingly. This prevents stockouts, reduces excess inventory, and minimizes carrying costs.
- 6. Fraud Detection: Data mining can be employed to detect fraudulent activities in supermarkets. By analysing transactional data, anomalies or patterns indicative of fraudulent behaviour can be identified. This helps supermarkets in detecting activities like fraudulent returns, coupon abuse, or unusual purchasing patterns, thereby safeguarding their revenue and maintaining a secure shopping environment.
- 7. Store Layout Optimization: Data mining can assist in optimizing the layout of the supermarket. By analysing customer movement patterns within the store, supermarkets can understand how customers navigate the aisles, identify popular areas, and optimize the placement of products and displays. This improves customer flow, enhances the shopping experience, and increases sales.

Marketing Campaign Analysis: Data mining techniques can be applied to evaluate the effectiveness of marketing campaigns in supermarkets. By analysing customer response data, supermarkets can measure the impact of different marketing channels, promotions, and advertisements. This helps in optimizing marketing budgets, identifying successful strategies, and refining future campaigns.

By applying data mining methods to these areas, supermarkets can gain valuable insights, make informed decisions, enhance customer satisfaction, optimize operations, and ultimately improve their overall performance and competitiveness^[15]

Future Scope

The competitive climate in which supermarkets and grocery shops operate forces them to pursue customer-centric methods. Since one of the keys to success Customer relationship management is crucial to the formulation of such a plan; supermarkets should determine the most lucrative strategies to cultivate and sustain a loyal customer connection. With the introduction of Business Analytics and data mining, retailers now have new techniques to transform the massive quantity the information they have into meaningful information to be able to acquire consumer perceptions and strengthen customer interactions. Many grocery businesses employ data mining to assist them better understand their customers' buying habits and how to retain valuable consumers. Many people purchase things on a regular basis when they visit the store. Data mining may assist the store in learning about the patterns of client inclinations. Where supermarkets are competing fiercely to preserve its benefits and get more clients, encouraging the industry to employ innovative methods to please customers and enhance the company's profits.

Customer Target

Supermarket operators contact customers to uncover the characteristics of the customer that are most important to them in order to carry out customised marketing campaigns. Every now and again, They devise strategies, make offers, and



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engage with customers via text messages and email to deliver information about grocery store and supermarket offers of interest to consumers in order to increase sales.

Conclusion

As the economy grows, there is a significant expansion in the use of data mining in the retail business, particularly in large-scale supermarkets. As a result, it becomes quite difficult.

It is critical to develop a suitable model for data mining technologies in order to give a decision-making process in supermarkets. We present a data mining based approach for detecting trends in consumer behaviour. This framework has the potential to alter improve the structure of retailer-consumer relationships by allowing businesses to realise customers' purchasing missions throughout their supermarket shopping trips.

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