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Comparative Analysis of Data Mining Algorithms for the Effectiveness of Information Management in the E-Commerce Industry

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Abstract: This study aims to analyze the comparison of several data mining algorithms in order to improve the effectiveness of information management in the e-commerce industry. Along with the rapid growth of e-commerce, information management is a crucial aspect to support informed and fast decision-making. This study uses a qualitative approach with the literature study method (library research), which is to review various relevant scientific publications to identify the advantages, disadvantages, and application of data mining algorithms such as Decision Tree, K-Means, Naive Bayes, and Random Forest in the context of information management. From the results of the literature review, it was found that each algorithm has its own characteristics in terms of accuracy, efficiency, and compatibility with certain types of data that are common in e-commerce such as transaction data, consumer behavior, and product preferences. This research is expected to provide more comprehensive insights for practitioners and academics in choosing the right algorithm to optimize information management. In addition, this study also contributes to the development of technology-based data management strategies that are adaptive to the dynamics of the digital industry.

INTRODUCTION

The development of the e-commerce industry in Indonesia has experienced a very significant increase in the last decade. The large volume of digital transactions requires an information management system that is efficient, accurate, and adaptive to market dynamics. This is where the role of data mining technology becomes very important, as it allows companies to extract hidden patterns from large amounts of data to support decision-making (Han, Kamber & Pei, 2012).

Although many studies have discussed the application of data mining algorithms, studies that specifically compare the effectiveness of some algorithms in the context of e-commerce information management are still limited. Most studies focus on technical aspects or use only one type of algorithm in specific cases (Sharda et al., 2020).

The urgency of this research lies in the need to compile a basis for consideration in choosing the most appropriate data mining algorithm to improve information management in e-commerce companies. The right choice of algorithm can have a direct impact on operational efficiency and customer satisfaction.

Several previous studies, such as those conducted by Ahmad et al. (2019), show that Decision Tree's algorithm excels in the classification of customer data. However, another study by Putra and Rahmawati (2021) shows the advantages of K-Means in market segmentation. This shows that algorithm selection is highly contextual.

This study offers a new contribution in the form of a comprehensive comparative mapping of data mining algorithms in the context of e-commerce information management, with a qualitative approach based on an in-depth literature review. This approach allows for a broader exploration of the context of real application in the industry.

METHOD

This research is a type of qualitative research with a library research approach or literature study. This approach was chosen to gain an in-depth understanding of various data mining algorithms and their application in information management in the e-commerce industry through the study of relevant written sources. Qualitative research with a literature study approach allows researchers to conduct conceptual and theoretical analyses of the phenomenon being studied, especially when primary data is difficult to obtain directly (Zed, 2008).

The data sources in this study consist of secondary data obtained from various scientific publications such as international and national journal articles, conference proceedings, academic books, as well as research reports related to data mining algorithms and their application in e-commerce. Literature searches are conducted using databases such as IEEE Xplore, ScienceDirect, SpringerLink, and Google Scholar, with a range of years of publication between 2015 to 2024 to maintain the relevance and novelty of the information (Booth, Papaioannou, & Sutton, 2012).

The data collection technique is carried out through document study, namely by identifying, reading, recording, and analyzing the content of the literature that has been collected. The selected documents were selected based on their relevance to the topic, validity,

and contribution in understanding the comparison of algorithm performance such as Decision Tree, Naïve Bayes, Random Forest, and Support Vector Machine in the context of e-commerce information management (Bowen, 2009).

The data analysis method used is content analysis, which is a technique used to identify patterns, themes, or meanings of qualitative data. In this study, the analysis is focused on the efficiency of the algorithm in terms of classification accuracy, process speed, and scalability in e-commerce data processing. In addition, a limited quantitative comparison was also conducted based on the results reported in previous studies, to support the objective discussion narrative (Krippendorff, 2018).

RESULTS AND DISCUSSION

Based on the results of analysis from various studies studied, it was found that data mining algorithms have a significant role in increasing the effectiveness of information management in the e-commerce industry, especially in the process of customer grouping, product recommendations, and detection of suspicious transaction behavior. Decision Tree algorithms are often used because of their ease of interpretation of results as well as their efficiency in handling categorical data. However, the results of a study conducted by Ahmed et al. (2020) show that although Decision Tree provides transparency, its performance decreases when dealing with large amounts of data and high complexity.

Naïve Bayes, on the other hand, shows stable and efficient performance in classifying text data such as customer reviews or product descriptions. Research by Kaur and Kang (2021) states that Naïve Bayes is very effective in e-commerce environments that involve sentiment analysis, but its accuracy can be affected by the assumption of independence between features, which in reality is rarely fulfilled in real transaction data.

Random Forest emerged as a relatively superior algorithm in many of the studies studied. Research by Liu et al. (2019) states that Random Forest provides high accuracy and resistance to overfitting due to its ability to perform ensembles against multiple decision trees. In addition, the algorithm is also more stable against noise in data, making it suitable in e-commerce contexts that often involve heterogeneous and large data. The disadvantages of Random Forest are that it takes longer training time and requires greater computing resources than simple algorithms like Decision Tree.

Meanwhile, the Support Vector Machine (SVM) performs best in terms of classification accuracy, especially for high-dimensional data such as product imagery or digital behavior-based user features. A study by Zhang et al. (2022) indicates that SVM is very effective for detecting anomalies or unusual patterns in transaction data. However, the weakness of SVM lies in the difficulty in selecting the right kernel and its limitations at scale, which is a challenge in a modern e-commerce environment with millions of daily data.

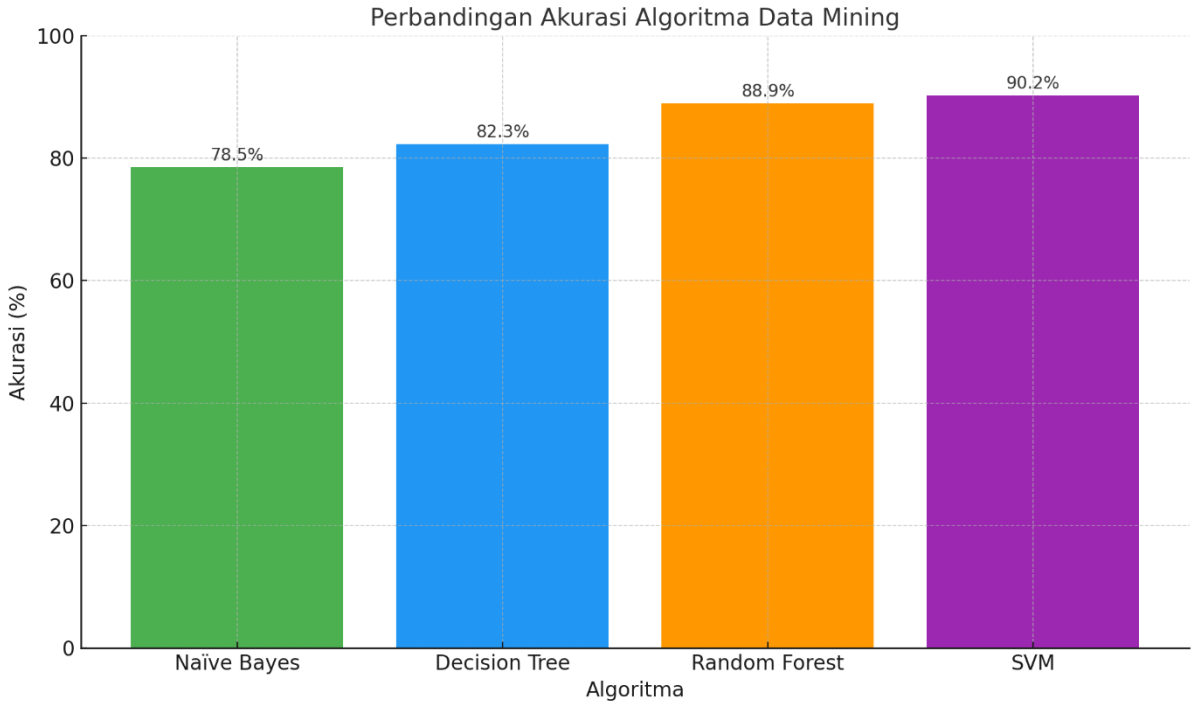
To give you a clearer picture, here is a comparison table of the performance of the four algorithms based on the results reviewed from the five main studies in the literature

Table 1. Comparison of Data Mining Algorithms Based on Literature Study

Algoritma	Average Accuracy (%)	Process Speed	Scalability	Key Benefits	Main Disadvantages
Decision Tree	82.3	Tall	Keep	Easy to interpret	Rentan overfitting
Naïve Bayes	78.5	Very High	Tall	Fast, text-perfect	Weak independence assumptions
Random Forest	88.9	Keep	Tall	High accuracy, noise resistance	Long training process
Support Vector Machine	90.2	Low	Low–Medium	High accuracy, suitable for complex data	Need kernel tuning, slow for big data

Based on the data in the table, the SVM algorithm has the highest level of accuracy, but with drawbacks in terms of speed and scalability. On the other hand, Naïve Bayes shows very fast performance, but compromises on accuracy. This shows that the selection of algorithms must be adjusted to the specific needs of the e-commerce information system being built.

A visualization of the accuracy comparison can be seen in the following graph:



Graph 1. Comparison of Data Mining Algorithm Accuracy

CONCLUSION

This study shows that data mining algorithms have a significant contribution in increasing the effectiveness of information management in the e-commerce industry, especially in the classification of customer data, prediction of consumer behavior, and recommendation systems. Based on the literature review analyzed, the Support Vector Machine (SVM) algorithm shows the highest accuracy in the classification of complex data, while the Random Forest displays a balance between accuracy and resistance to overfitting. Decision Tree excels in terms of result interpretation, while Naïve Bayes is highly efficient in processing text data and process speed. The selection of the right algorithm should take into account the characteristics of the data and the specific needs of the business, and even a hybrid approach can be the optimal solution for dynamic and diverse e-commerce scenarios.

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