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ANALYSIS OF BOOK BORROWING PATTERNS IN STUDENTS OF THE FACULTY OF ECONOMICS AND BUSINESS, NATIONAL UNIVERSITY USING APRIORI ALGORITHM

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Abstract
This study aims to analyze book borrowing patterns at the Library of the Faculty of Economics and Business, National University using the Apriori algorithm. The analysis was conducted on borrowing transaction data to identify relationships among book categories that are frequently borrowed together. The dataset consisted of 68 borrowing transactions covering 11 book categories. Although the number of transactions was relatively limited, the data were selected based on the availability of complete borrowing records during the observation period and were considered sufficient to identify initial borrowing patterns. The results reveal several significant patterns. The "Management" category obtained the highest support value of 40%, indicating that it was the most frequently borrowed category, while the rule "Management → General Management" achieved a confidence value of 70%, showing a strong tendency for both categories to be borrowed together. These findings demonstrate that the Apriori algorithm can effectively identify user borrowing preferences from circulation data. This study contributes to the development of data mining applications in library science, particularly in the use of association analysis to support evidence-based library management. The findings may assist librarians in optimizing collection arrangement, developing recommendation systems, and improving collection development strategies. Furthermore, this study highlights the potential of transaction data analysis as a practical approach for understanding user information needs in academic libraries.
Keywords: Apriori algorithm, book lending, associative rules, data mining, libraries

INTRODUCTION

Libraries play an important role in supporting learning, research, and access to information within educational institutions. According to Suwarno (2010), a library is a work unit that has a task as a source of information that can be used by users. In addition, Rahayu (2017) also argues that libraries are one of the important elements in supporting education, research, and science development activities in the academic environment. As an information center, libraries not only provide a wide variety of literature but also function as a learning and collaboration space. With the increasing number of collections and library users, the need for efficient data management is increasing. In fact, this data contains important information regarding user borrowing behavior, book usage patterns, and the relationships between

frequently borrowed collections. Therefore, libraries need to adopt an analytical approach that can transform transaction data into meaningful information to support library services and service optimization

The library has important data, one of which can be used in the process of managing data in the library, including data on book lending transactions. According to (Ayu Hapsari, 2020) data on book lending transactions can be used in decision-making or can be used for research. In the decision-making process of utilizing data, it is not enough to use operational data but it is necessary to conduct a deeper analysis of a data (Rusdianto et al., 2020). Promnuchanont & Kosarat, (2023) also pointed out that association rule mining can be used to analyze students' library usage behavior and identify borrowing patterns based on transaction data.

Advances in technology and information and the existence of data mining are considered to provide convenience in processing data that has large transactions and will later become valuable information. One of the relevant methods for this book borrowing transaction data is the Ari Algorithm. This algorithm was first proposed by Agrawal and Srikant to find patterns in the relationship between items in a transaction (Kaur et al., 2014). In the field of libraries, a priori algorithms can be used to analyze book itemsets that are often borrowed together. This pattern is called associative rules which will later be used in cataloging, providing book recommendations, or can be used in book procurement (Kurniawan, 2019). In the National University Library, the number of borrowing transactions from the faculty of economics and business is one of the highest number of borrowers and with this analysis, the library can identify frequently borrowed books at the same time, understand the information needs of students, and improve service efficiency. For example, if it is found that books on "research methods" are often borrowed along with books on "basic statistics," the library may compile a collection or recommend similar books to make it easier for users to access. Previous research by (Azwar, 2014) with the title Analysis of Library Book Borrowing Patterns Using a Priori Algorithm by utilizing orange machine learning so that a combination of existing borrowing was found. In this study, calculations are carried out manually and will be compared with calculations using orange data mining. So this study focuses on the results of a comparison of two ways. The second research was conducted by (Suryati, 2022) with the title Analysis of Book Borrowing Patterns Using a Priori Algorithm. The results of this study show that the analysis of book lending transactions in libraries with a minimum support limit of 30% and a minimum confidence of 60%, formed 9 rules in 2017 and 2018 while in 2019 there were 10 rules. The resulting pattern is a recommendation to the library to arrange the layout of the book. Another research by Sianturi (2018) with the title Application of a Priori Algorithm for Determining Order Levels. The results of the research show that the analysis of association rules can help identify the most orders with the Tanagra tools. In the context of libraries, similar research can be applied to understand the patterns of resource use by students.

Although previous studies have discussed and applied the A-priori algorithm, most of them have focused on the library as a whole using different datasets. Furthermore, previous studies have not focused on specific transaction patterns, such as borrowing patterns within a particular field of study. Therefore, further research is needed to analyze borrowing patterns using transaction data from this library context to identify relationships among categories of frequently borrowed books.

This study aims to analyze book lending data in the National University Library using a priori algorithm to find significant book borrowing patterns. In addition, a priori algorithm was also applied in this study to analyze book borrowing patterns in students of the Faculty of

Economics and Business, National University which has a focus on the needs of economics students. This analysis will be based on two metrics, namely support and confidence, to produce quality rules. With these results, later the library can optimize services and collection management. The structure of this article is divided into the following, part 2 discusses the theoretical foundation, part 3 discusses research methods, ranging from data cleaning to data interpretation, part 4 discusses the results of the findings, part 5 discusses the discussion of the findings, and part 6 is the conclusion of the research.

RESEARCH METHOD

Data mining is the process of analyzing data using large amounts of data that are used to find patterns, relationships, and valuable information in the data. Turban et al. (2011) define data mining as an automated-semi-automated process, which is used in big data analysis as well as to find patterns such as clustering, association rules, and predictions. Badrul (2016) argues that in the process of data mining, the use of statistics, mathematics, and computer algorithms is needed to see random or invisible patterns. So data mining can be considered as a step in the Knowledge Discovery in Databases (KDD) process which aims to find patterns and information from big data that can be used. Data mining has many groups and one of them is a priori algorithms. A priori algorithm is one of the algorithms in data mining used to search for associaton rules and frequent itemsets. This algorithm has the principle that if an itemset appears frequently, then its subset will appear frequently as well. This algorithm is considered popular in analyzing transaction data, such as purchasing goods in stores or borrowing books in libraries. This study uses secondary data obtained from library borrowing records at the Faculty of Economics and Business at a national university. The data consists of 68 borrowing transactions involving books collected over a one-year period in 2025. These transactions were selected based on the completeness and consistency of the loans so that the data could be processed in an association analysis. Although the number is limited, the data is considered sufficient to identify borrowing patterns and relationships between book categories within the selected scope of the study. The following are the steps to perform a priori algorithm (Srikanti et al., 2018):

Defining Frequent Itemsets

At this stage, a search for combinations of items that meet the minimum requirements for support values is carried out with the following formula:

$$\text{Support(A)} = \frac{the\ number\ of\ transactions\ contains\ A}{Total\ transactions}$$

For the support value of 2 items, the following formula is used:

$$\text{Support(A,B)} = \frac{\sum transaction\ contains\ A\ and\ B}{\sum transaction}$$

Determining Association Rules

To calculate confidence is used:

$$\text{Conf (a b)} = \frac{the\ number\ of\ transactions\ containing\ A\ and\ B}{Total\ transaction\ a}$$

Various kinds of bus tools we use in data mining. In this study, the author uses RapidMiner. RapidMiner is one of the platforms used to analyze data and data mining. RapidMiner can be used in a wide variety of algorithms and other data analysis techniques. In this RapidMiner, it has the advantage of being able to process a large amount of data and also provides convenience in applying complex analytical models. RapidMiner is designed to assist

users in conducting data analysis including data preprocessing, modeling, model evaluation, as well as the application of machine learning and data mining modeling techniques, model evaluation, and the application of machine learning and data mining techniques (Mierswa et al., 2014). Rapid Miner can be used in a variety of algorithms such as decision trees, k-means clustering, and a priori algorithms for association analysis. The results displayed from RapidMiner can be presented in a visual form of graphs. This makes RapidMiner one of the software that can be chosen to perform data extraction and apply various ata mining methods (Syahab & Purnama, 2023).

In conducting research there are several stages that must be carried out by the author, the stages are as follows:

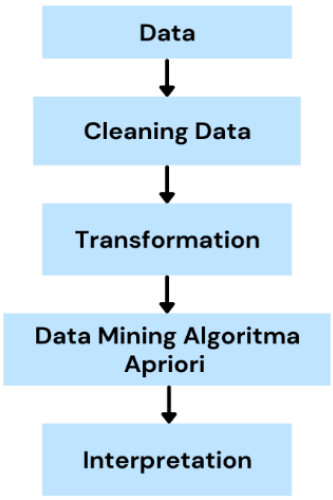


Figure 1 research stages

Cleaning Data

The first step taken is to clean the data that we will analyze or we can call the data cleaning process. In this process, the same data is deleted, inconsistent data is deleted, and corrections are made to typos in the data. In addition, data enrichment needs to be carried out as an addition of new information to strengthen the data set used (Manurung & Hasugian, 2019).

Transformation

Transformation is the process of transforming raw data into data that has a format that is in accordance with the needs of analysis or in accordance with the data processing to be carried out. The purpose of the transformation process is to improve the quality of the data owned and make the data easier for the system to understand. This transformation process can be carried out by coding according to the pattern of information being explored (Manurung & Hasugian, 2019)

Data Mining

Data mining is in the core stage of KDD, which is that interesting information has been found from the data that has been processed. In this process, various techniques or algorithms will be used based on the analysis to be carried out. In this case, success will be influenced by the suitability of the technique or algorithm with the overall needs of the KDD process

Interpretation / Evaluation

After the data mining process is carried out, the data must be presented in a form that is easy to understand. This stage has the purpose of assessing the relationship of the patterns found as well as evaluating the patterns. Good interpretation is one that can ensure that the information generated can be used to support effective decision-making

RESULT AND DISCUSSION

The data on book borrowing transactions collected was 68 transactions from the Faculty of Economics and Business. The books are categorized into 11 books, namely: (1) accounting, (2) general management, (3) management, (4) general science, (5) economic ethics, (6) financial economics, (7) production and industry, (8) economics, (9) macroeconomics, (10) civil law, (11) analysis.

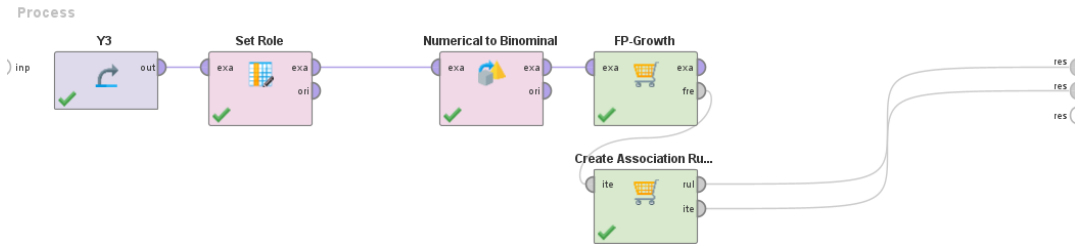
Table 1 Tabular format data table

Accountancy	General Management	Management	General Science	State finance
1	0	0	0	0
0	1	1	0	0
0	1	0	1	0
1	0	0	0	0
0	0	0	0	0
0	0	1	0	0
0	1	1	0	0
0	0	0	0	1
0	0	0	0	0

Economic ethics	Financial Economics	Production and Industry	Economics	Macroeconomics	Civil law	Analysis
0	0	0	0	0	0	0
0	0	0	1	0	0	0
0	0	0	1	0	0	1
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

Then the data from excel will be processed using RapidMiner FP-Growth and Association Rules

Figure 2 visualization using rapidminer



From the results of the application of the priori algorithm, the following results were obtained:

Table 2 Support 1 Item

No	Itemset	Support
1	Management	40%
2	General Management	24%
3	Financial Economics	23%

Table 3 Support and Confidence 2 Itemset

No	Rules of Association	Support	Confidence
1	If you borrow a general science book, you will borrow a general management book	8,7%	50%
2	If you borrow an economics book, you will borrow an analysis book	4,3%	50%
3	If you borrow an analysis book, you will borrow a general management book	5,8%	57%
4	If you borrow an analysis book, you will borrow a management book	5,8%	57%
5	If you borrow an economics book, you will borrow a general management book	5,8%	66%
6	If you borrow an economic ethics book, you will borrow a financial economics book	5,8%	66%
7	If you borrow an economics book, you will borrow a general science book	5,8%	66%
8	If you borrow a management book, you will borrow a general management book	17%	70%
9	If you borrow an analysis book, you will borrow a general science book	7%	71%

Table 3 is the result of the analysis of association rules generated from the Apriori algorithm to find the pattern of relationships between items based on transaction data with 20% support and 50% confidence. The support column shows the percentage of transactions that contain a combination of Premises and Conclusion, while confidence describes the probability of a Conclusion if a Premises has occurred.

Based on the results from table 3, several patterns can be analyzed in depth. For 1 itemset, 3 books were found that met the support above 20%, namely management, general management, and financial economics. As for the 2 itemsets found, the General Science → General Management rule had a support of 8.7%, indicating that this combination appeared in 8.7% of the total transactions, with 50% confidence, which means that if someone chose the "General Science" category, then there was a 50% chance that they would also choose "General Management." The same is seen in the Economics → Analysis rule, which has a support of 4.3 and a confidence of 50%, indicating that this combination is rare, but the relationship between "Economics" and "Analysis" remains relevant. On the other hand, the General Management → Analysis and Management → Analysis rules each have a support of 5.8% with a confidence of 57.1%, indicating a fairly strong relationship between "Analysis" and the two categories.

A more significant rule is seen in Economics → General Management, which has support of 5.8% and confidence of 66.7%. This relationship shows that when someone chooses "Economics," there is a great chance that 66.7% of them will also choose "General Management." A similar pattern can be seen in Economic Ethics → Financial Economics and Economics → General Sciences] with support of 5.8% and confidence of 66.7%, respectively. However, the rules with the highest support are Management → General Management, which has a support value of 17.4% and confidence of 70.6%. This suggests that this combination is most commonly found in transactions and has a very strong relationship. Another significant rule is General Science → Analysis, with support of 7.2% and confidence of 71.4%, which is the rule with the highest confidence in the table. The table above shows that the transactions made tend to be 1 book loan transaction. However, it was also found that there were predictions for borrowing 2 books with a confidence value above 50% even with transactions that were not too large.

In association rule mining theory, the occurrence of one item may increase the probability of another item appearing in the same transaction dataset (Mündler, 2019). Although some rules yielded scores with relatively low support, the confidence scores obtained were relatively high. This indicates that while the frequency of these transactions is limited, the relationship between specific books remains significant. The relatively small number of transactions is influenced by the limited observation period of one year and the characteristics of users within a specific scope. However, these findings suggest that the A-priori algorithm can be used to identify borrowing patterns even with a small dataset.

These findings align with previous research by Srikanti et al. (2018), which showed that borrowing transaction analysis generally yields low support values due to the limited frequency of transactions, yet still produces confidence scores. Azwar (2014) also argued that high confidence scores indicate a strong likelihood of related items appearing together in a borrowing transaction. Compared to previous studies, this research specifically highlights borrowing patterns among students in the faculty of economics and business at a national university, which will provide a deeper understanding of borrowing behavior within a more specific scope. The findings of this study also support prior research stating that the A Priori algorithm can be used to assist libraries in managing book recommendation systems. Zhang & Zhang,(2023)also argues that association rule analysis can facilitate libraries in recommending books to users and improving service quality. Additionally, Adistia et al., (2019) state that association rule mining in libraries supports recommendation systems by identifying relationships among borrowed books.

From a practical perspective, the resulting association patterns can support library management in improving library services, whether in terms of the collection or the user

experience. Books with strong associations will be placed close to one another to facilitate user access. Overall, the results of the analysis provide important information about transaction data patterns. Support and confidence that have high values can be used in making suggestions or recommending to users of the "general management" book to users who choose the "management" book or can recommend users of the "general science" book to users who choose the "analysis" book. This information will later be used in cataloging to be more optimal and improve the user experience in searching and borrowing books. (Kurniawan, 2019)

CONCLUSION

The results of the analysis using the A Priori algorithm indicate that the “Management” category is the most frequently borrowed category by students in the Faculty of Economics and Business at Universitas Nasional, accounting for 40% of the total. Additionally, significant association patterns were identified, such as the relationship between the “Management” and “General Management” categories with a confidence value of 70%, as well as the relationship between “Analysis” and “General Science” with a confidence value of 71%. These results indicate that users tend to borrow books with related subject characteristics simultaneously, meaning borrowing behavior is based on academic needs and subject relevance.

The results of this study also demonstrate that the application of the Apriori algorithm is effective in identifying borrowing patterns and relationships between book categories from library transaction data. Thus, this study contributes to data mining techniques in library management. Additionally, this study demonstrates that borrowing transaction data can be processed and utilized as insights to recognize user borrowing behavior and collection usage,

However, this study still has several limitations. The first is the limited number of transactions—approximately 68—which may affect the diversity and strength of the resulting association rules. Second, the dataset is limited to borrowing transactions from students in the Faculty of Economics and Business at the National University, so the findings may not fully represent borrowing behavior in other academic environments or faculties.

SUGGESTION

Therefore, for future studies, it is recommended to use a larger and more diverse dataset to produce an even more comprehensive analysis. Further research could also compare the performance of the Apriori algorithm with other data mining methods to assess the accuracy of different approaches in analyzing library borrowing patterns

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