Article

Association Analysis in Java Ateka for Stationery Sales Promotion Using the FP-Growth Algorithm

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Abstract:

Every company or organization must have the right strategy to continue business or organizational activities. If not used, product sales data at the company will only become a pile of data; of course, it is regrettable if it is not used properly. The company can use the most product sales data to determine the next marketing strategy. To find out this data (the most sales), Association Rules Analysis is needed on the FP-Growth Algorithm method. This research aims to determine the association rule of Java ATK sales using the FP-Growth algorithm. This algorithm can be used for extensive data sets and to process Big Data. The results of this study are the FP Growth algorithm using association rules, which can be implemented in bookstore sales data with support count and minimum confidence parameters. A decimal value of 0.8 can form a product purchase correlation to increase stationery sales in Java Ateka. The rule obtained from the results of the FP-Growth calculation is that there are three transactions where if you buy item A, you will buy item B.

Keywords: Data Mining, Rule Association, FP Growth, RapidMiner, Stationery Sales

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1. INTRODUCTION

The challenge for many companies is processing extensive data collection to extract meaningful information from consumer data and the products they buy to increase their competitiveness. *Java Ateka* bookstore is a retail bookstore engaged in selling books, stationery, and school and office supplies. Sales transactions at the *Java Ateka* Bookstore occur daily, so sales data always increase over time. Companies can use this data to maximize product promotions, to promote a product; a data mining process is needed to mine data from daily sales transactions.

The problem in this company is that the Java Ateka Bookstore does not yet have the tools to carry out data mining processes that aim to analyze shopping carts, making it difficult to carry out targeted promotions. Promotions are related to customers who often buy books, buy stationery, school supplies, and other product shopping patterns. Often the products promoted are not on target, so the results are not optimal. This research was carried out so that the sales promotion by Java Ateka Bookstore was more targeted according to shopping cart analysis. The algorithm used in determining sales promotions is Frequent Pattern Growth (FP-Growth) with association rules. Association analysis aims to find

relationships between variables, which often appear simultaneously in a dataset [1]

FP-Growth algorithm is one of several frequently influential pattern mining methodologies, in which a pattern, e.g., a set of items, sequences, subtrees, or substructures) often occurs if the Frequency with which it appears in the database is not less than a specified minimum support threshold [2]. FP Growth algorithm also has the performance and scalability of FP-Tree; for extensive data sets, it will not fit in memory, making it challenging to process Big Data. Distributed and parallel implementation of the FP growth algorithm is required to scale to large data sets. [3]

2. THEORY

A. Previous research

Supiyandi et al. (2017), entitled Association Rules Analysis on FP-Growth Method in Predicting Sales, discusses transaction data that is increasing daily; large amounts of data can be a problem for companies if not managed well. The purpose of this study is to analyze fruit sales which will be used to determine the itemset of promotional strategies in improving sales quality. The study used the FP-Growth method. The result of this research is that data mining can be implemented using a sales database to find trends in the combination of item set patterns to be used as valuable information in decision-making. [4]

Furthermore, Sita Anggraeni et al. (2019) conducted research entitled Analysis of Sales by Using Apriori and FP Growth at PT. Panca Putra Solusindo, the research discusses the importance of business developers in finding strategies that can increase product sales and marketing. This research aims to determine to what extent the Apriori and FP-Growth algorithms can help develop marketing strategies by implementing the Weka data mining application software. This research uses the Apriori Algorithm method and Frequent Pattern Growth. The result of this research is to know clearly what products sell high in a period, while the FP-Growth algorithm produces several rules that have the most value, namely the frequent itemset. Therefore, they can provide data to marketing to find out in the future in planning sales strategies to improve performance better. [5]

Another research was conducted by Wira Hadinata et al. (2021) entitled Comparison Of A priori And Frequent Pattern Growth Algorithm In Predicting The Sales Of Goods; this research discusses the problems experienced by PT. Suka Maju still implements unrelated so that consumers find it challenging to buy related products. This research aims to compare two algorithms, the a priori algorithm and the Frequent Pattern Growth algorithm, to choose a better algorithm to help find products often purchased together, such as basic necessities and food. This research uses the Apriori Algorithm method and Frequent Pattern Growth. The result of this research is to apply the concept of the Internet of Things to the results of the implementation of tools and tests carried out on electronic devices and applications. [6]

Jing Yang, et al (2019) Research entitled Operation Anomaly Monitoring of Customer Service Data Analysis Platform Based on Inproved FP-Growth

Algorithm discusses monitoring anomaly operations of customer service data analysis platforms. The purpose of the study is to the long-time monitoring and poor monitoring accuracy in the customer service data analysis platform operating abnormality monitoring method, customer service data analysis platform operating abnormality monitoring method based on the improved FP-Growth algorithm designed. The results of the study are the average recovery time of the proposed customer service data analysis platform operating anomaly monitoring method is 5.239 seconds, and the average platform operating anomaly accuracy rate is 97.3%, indicating that the customer service data analysis platform is integrated with FP improved-Growth algorithm is operating abnormally Monitoring method performs better. [7]

B. Decision Support System

DSS is an interactive information system that provides modeling, data, and information manipulation, which is used to assist decision-making in structured and semi-structured situations [8]. So, it can be concluded that the Decision Support System is an interactive method that allows decision-making using analysis with available models aimed at:

a. Assist managers in making decisions, both structured and semi-structured.
b. Provide support at the manager's discretion.
c. Increase the effectiveness of the decisions taken for the better.
d. Computing speed allows decision-makers to do many computations at a low cost and quickly.

C. Rule Mining Association (ARM)

Association rule mining is a data mining method that combines an item into associative rules. In particular, the interesting association analysis stage is producing an efficient algorithm through high-frequency pattern analysis. [9] Association rule mining is one of the most appropriate methods used in finding frequent patterns in transaction data [10]. So it can be concluded that this method is very supportive of transaction data processing because each transaction has several items that will be recommended by finding patterns between items in transactions.

D. Data Mining

Data mining is a method of extracting data to find patterns that can be classified into useful knowledge [11]. So, it can be concluded that data mining is used to find added value from a data set in the form of knowledge that has not been known manually. Data mining aims to obtain patterns or relationships that give a useful indication of one classification mode, namely, FP-Growth [12]. Data mining can be used for mathematical, statistical calculations, artificial intelligence, and machine learning in identifying and extracting useful information related to large databases [13]. The data mining function [5] is as follows :

a. The description is used to give a brief overview of several large data types.
b. Estimation is used in estimating previously unknown values.
c. Prediction is to predict the future value.

d. Classification is the process of finding a function that distinguishes a data class concept, which aims to estimate the class of an object whose label is unknown.
e. Grouping is the process of grouping data that has certain characteristics.
f. Association or market basket analysis is to identify a product that consumers might buy together with other products.

E. FP-Growth

The FP-Growth algorithm is an alternative used in determining the data set that often appears in the data set [14]. FP-Growth is also used as a system to recommend a product [15]. So, it can be concluded that FP-Growth is a data mining method used to find products that often appear by searching for frequent itemsets without using candidate generation, which builds data using the FP-Tree structure in processing transaction data. FP-Growth is divided into three steps [14], namely:

a. FP-Tree Construction, at this stage, a tree is formed that functions to find the Frequency of the itemsets; each itemset is made a tree, and one itemset is added, which is taken from transaction data that is made for each path.
b. Generating FP-Growth, this stage aims to find the pattern and number the itemset based on the final FP-Tree that was previously formed so that a conditional FP-Tree is formed.
c. A frequent itemset is the last stage in the FP-Growth process used to install the itemset pattern based on the conditional FP-Tree to form a frequent itemset.

F. Rapid Miner

Rapid Miner is software that is used to see how accurate a product sales transaction data is to see the results of combination patterns generated by associations that have been adjusted using the FP-Growth algorithm [14]. So, it can be concluded that rapid Miner is data testing software that functions to display data visualization from the results of association calculations that have been adjusted to the FP-Growth algorithm.

3. METHOD

The research method is the steps taken to collect some information as an overview of the research design that is made. The research methodology is described in a framework. This framework starts by conducting a preliminary study to produce a system that, after being tested, can fulfill the objectives and can solve the problems being studied [16].

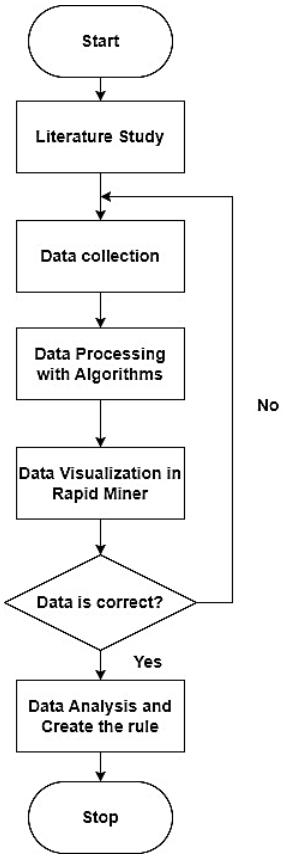

Figure 1. Thinking Framework

The method in this research is as follows:

- *Study of literature*

It is a series of activities related to data collection methods. Literature study in this research is by looking for data on research objects looking for references from previous studies, both from journals, books, and the internet.

- *Data collection*

The data collection method used in this study is the interview method. The interview is a data collection method carried out face-to-face between researchers and informants to obtain the required data. Interviews were conducted to explore and get the right information by giving a number of questions the resource person would answer.

- *Data Processing With Algorithms*

This study uses FP-Growth as a data processing technique. The stages of processing data mining using FP-Growth are as follows [17] :

a. The stage of generating the conditional pattern base
b. FP-Tree generation stage
c. frequent itemset search stage

- *Data Visualization in Rapid Miner*

Rapid Miner is a solution to analyze data mining, text mining, and grouping analysis [18]. Rapid Miner itself uses descriptive and predictive techniques to provide insight to users so they can make the best decisions.

3. RESULT AND ANALYZES

A. Generation of conditional patterns

At this stage, collecting data from the research object is a list of products sold by Java Ateka as follows in Table 1.

Table 1. Ateka Java Product Data

Item Code	Items
A	Notebooks
B	Ruler
C	School bag
D	Calculator
E	Crayon
F	Ballpoint
G	Pencil
H	Eraser
I	Book Binder
J	Study desk

From table 1, it is explained that the products in Java Ateka consist of 10 products; where these products are the products that appear most often or are most frequently purchased based on sales transaction data on Java Ateka for the past month. This data will be grouped into three products in one transaction, which meet the criteria for product data that are often sold in the last month. Therefore, the resulting transaction model is as follows the table 2.

Table 2. Transaction Data

Transaction ID	Item Set
1	Notebook, Pen, Ruler
2	Study Desk, Pencil, Eraser
3	Pencil, Eraser, Ruler
4	Book Binder, Crayon, Notebook
5	Calculator, Book Binder, Pencil
6	Ballpoint Pen, Ruler, Study Table
7	School Bag, Study Desk, Calculator
8	Crayons, Notebook, Pencils
9	Eraser, Pencil, Book Binder
10	School Bags, Crayons, Notebook
11	Bookbinder, ballpoint pen, calculator
12	Ballpoint Pen, Ruler, Study Table
13	Binder Books, Notebooks, Ballpoint Pens
14	Ballpoint Pen, Calculator, Ruler
15	Notebook, Ballpoint Pen, Pencil

From the transaction data in table 2, the itemset data is obtained, which is used as a reference for a tabular table formation. The transaction data is 15 transactions in which each transaction has three itemsets in it. Moreover, The tabular table former is used to make it easier to find item sets that appear frequently or frequently sold in Java Ateka, tabular data as shown in Figure 2.

Data Transaksi Bentuk Tabular

	Buku Tulis	Penggaris	Tas Sekolah	Kalkulator	Krayon	Bolpoin	Pensil	Penghapus	Buku Binder	Meja Belajar
1	1	1	0	0	0	1	0	0	0	0
2	0	0	0	0	0	0	1	1	0	1
3	0	1	0	0	0	0	1	1	0	0
4	1	0	0	0	1	0	0	0	1	0
5	0	0	0	1	0	0	1	0	1	0
6	0	1	0	0	0	1	0	0	0	1
7	0	0	1	1	0	0	0	0	0	1
8	1	0	0	0	1	0	1	0	0	0
9	0	0	0	0	0	0	1	1	1	0
10	1	0	1	0	1	0	0	0	0	0
11	0	0	0	1	0	1	0	0	1	0
12	0	1	0	0	0	1	0	0	0	1
13	1	0	0	0	0	1	0	0	1	0
14	0	1	0	1	0	1	0	0	0	0
15	1	0	0	0	0	1	1	0	0	0
Frekuensi	6	5	2	4	3	6	6	3	5	4

Figure 2. Tabular Data

The tabular data in figure 2 explains that each product that appears in the transaction is marked with the number 1, while the product that does not appear in the transaction is marked with the number 0. The item set that appears in each transaction has a frequency. Moreover, Frequency data from each item set can be seen in the following table 3.

Table 3. Per item Frequency

Item Code	Items	Frequency
A	Notebooks	6
B	Ruler	5
C	School bag	2
D	Calculator	4
E	Crayon	3
F	Ballpoint	6
G	Pencil	6
H	Eraser	3
I	Book Binder	5
J	Study desk	4

After the frequency results are obtained, the next step is to determine the support account, where the support account value is between 0 – 1. moreover, The item codes that meet the support count frequency >= 4 are A, F, G, B, I, D, and J. The data are as follows the table 4.

Table 4. The Frequency that meets the support count

Item Code	Items	Frequency
A	Notebooks	6
F	Ballpoint	6
G	Pencil	6
B	Ruler	5
I	Book Binder	5
D	Calculator	4
J	Study desk	4

The data in table 4 is product data that has been sorted from the highest number of frequencies that have met the support count. The seven data above will have an effect and will be entered into the FP-Tree, and those that do not meet the support count will be removed.

B. Generating Frequent Pattern Tree

After the items that meet the support count are formed, the next stage is the formation of the FP-Tree. Here are the dataset items based on priorities that were previously formed based on the results of transactions every day for one month:

Table 5. Item Set Transactions that meet the Support Count

Transaction ID	**Item**
1	A, F, B
2	G, J
3	G, B
4	A, I
5	G, I, D
6	F, B, J
7	D, J
8	A, G
9	G, I
10	A
11	F, I, D
12	F, B, J
13	A, F, I
14	F, B, D
15	A, F, G

Table 5 is the FP-Tree formation data which has been sorted based on the highest Frequency of products that have met the support count <= 4. From the results of the transaction data, then the formation of the FP - TREE is as following figure 3.

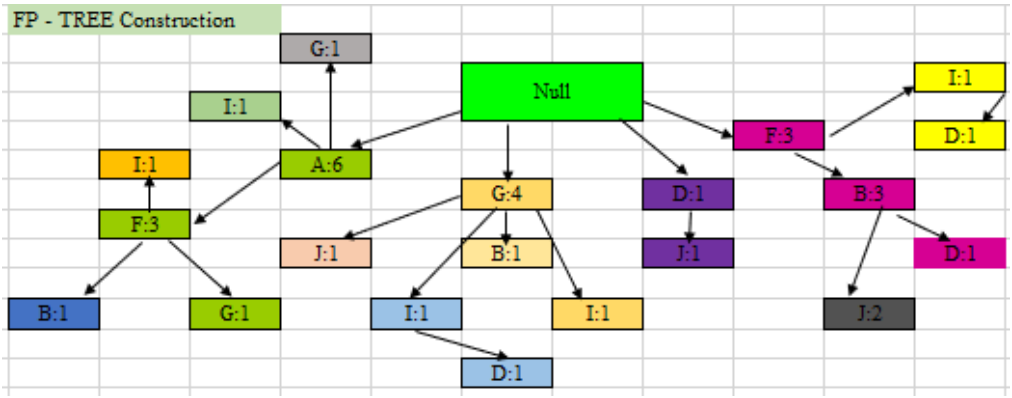

Figure 3. FP-Tree Construction

Each node in the FP Tree contains the product name, and the count support calculates the Frequency of occurrence of the product in each path. The data set is checked first to determine the support count of each product which does not meet the Frequency will be lost.

C. FP Growth Association Rules

The next step is to form an association rule for the FP-Growth algorithm. From generating the FP Tree, the conditional pattern base is generated as following table 6.

Table 6. Conditional Pattern Base

Items	**Conditional Pattern Base**
Ballpoint	{A, B:1}, {I, A:2}, {{B:3}, {G:1}
Notebooks	{F, B:1}, {I, F:2}, {G:2}
Pencil	{A, F:1}, {I:2}, {A, B:1}

The FP-Tree results are three items often purchased in 15 transactions, of which the three items have a conditional pattern base. This condition is a condition where if the data item buys item A, it will buy item B, or it can be interpreted that if product A is sold, then products B and C will also be sold. Moreover, After the conditional pattern data is generated, the next step is forming the FP-Tree frequent pattern base, as in table 7.

Table 7. Frequent Pattern Base

Item	Conditional Pattern Base	Frequent Pattern Base
Ballpoint	{B, J:2}, {A:3}, {I, D:2}, {G:1}, {B:2}	<A:3>, <B:4>, <J, D, I:2>, <G:1>
Write book	{F, B:1}, {F, I:2}, {F, G:1}, {I, G:1}	<B:1>, <F:3>, <I, G:2>
Pencil	{I, D:1}, {A, F:1}, {J, B, I:1}, {A:1}, {A:2}, {B, D, F:1}, {I:2}	<A:2>, <B, F:1>, <I:2>

Frequent pattern base FP - Tree is obtained by counting the number of items in the conditional pattern base. Frequent pattern base FP - Tree is the number of items that appear in each transaction or path.

D. Testing Using RapidMiner

Next is using the Rapidminer software to form a mining model on the FP Growth algorithm. First, create a dataset in tabular format in Excel, as shown in figure 4.

	A	B	C	D	E	F	G	H	I	J	K
1		Buku Tulis	Penggaris	Tas Sekolah	Kalkulator	Krayon	Bolpoin	Pensil	Penghapus	Buku Binder	Meja Belajar
2	1	1	1	0	0	0	1	0	0	0	0
3	2	0	0	0	0	0	0	1	1	0	1
4	3	0	1	0	0	0	0	1	1	0	0
5	4	1	0	0	0	1	0	0	0	1	0
6	5	0	0	0	1	0	0	1	0	1	0
7	6	0	1	0	0	0	1	0	0	0	1
8	7	0	0	1	1	0	0	0	0	0	1
9	8	1	0	0	0	1	0	1	0	0	0
10	9	0	0	0	0	0	0	1	1	1	0
11	10	1	0	1	0	1	0	0	0	0	0
12	11	0	0	0	1	0	1	0	0	1	0
13	12	0	1	0	0	0	1	0	0	0	1
14	13	1	0	0	0	0	1	0	0	1	0
15	14	0	1	0	1	0	1	0	0	0	0
16	15	1	0	0	0	0	1	1	0	0	0

Figure 4. transaction data tabular format

The second step is to run the software using rapid Miner, then read excel import data. The next step is to perform data processing using rapidminer with four operators. This data processing is carried out in stages, from selecting numeric attributes to binomial, fp-growth, and creating association rules to determine the minimum support for the fp-growth operator, with a decimal value of 0.8 and a minimum trust with a decimal value of 0.8.in full can be seen in Figure 5.

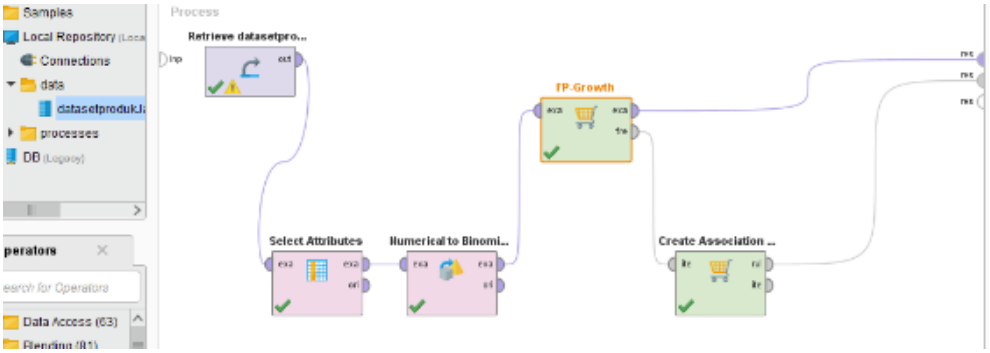

Figure 5. Fp-growth testing stages with rapidminer

Furthermore, after the data processing design is carried out, if you click start, it will display data based on the minimum calculation that has met support. The results are as follows in figure 6.

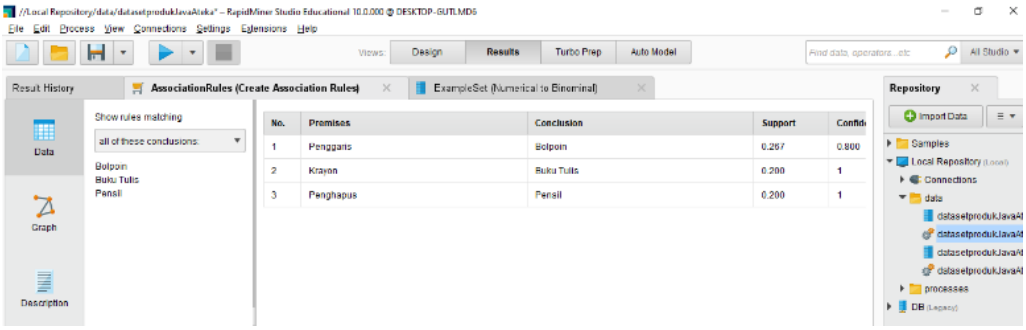

Figure 6. Result Association rule

Furthermore, the results of testing the FP-growth association using the rapidminer rule software are generated in figure 7.

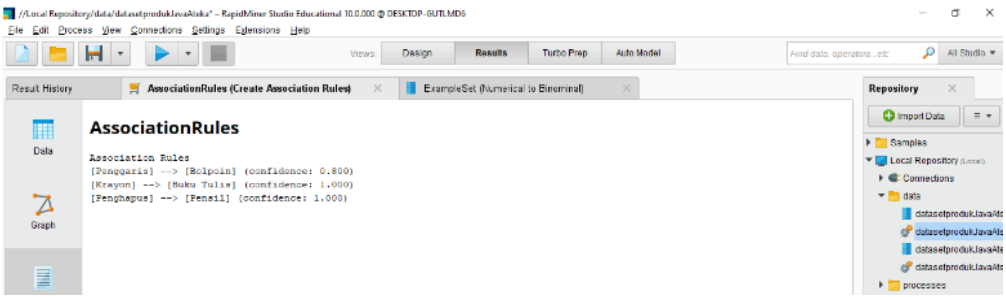

Figure 7. Association Rule

The rule obtained from the results of the FP-Growth calculation is that there are three transactions where if you buy item A, you will buy item B.

4. CONCLUSIONS

Based on research conducted in Java Ateka, it can be concluded that the FP Growth algorithm using the association rule can be implemented in bookstore sales data with support for count parameters and minimum confidence. a decimal value of 0.8 can form a product-purchase correlation to increase the sales of stationery in Java Ateka. After testing the software, rapidminer with the FP-growth algorithm as a result of processing sales data, the most frequently appearing are pens, notebooks, and pencils.

AUTHOR CONTRIBUTIONS

Conceptualization; Syafa Wajahtu Wardani [S.W.W], Silvia Windri Lestari [S.W.L], Nauffal Ammar Daffa [N.A.D], Imam Tahyudin [I.T], methodology; [S.W.W],[S.W.L],[N.A.D],[I.T], validation; [S.W.W],[S.W.L],[N.A.D],[I.T], formal analysis; [S.W.W],[S.W.L],[N.A.D],[I.T], investigation; [S.W.W],[S.W.L],[N.A.D],[I.T], data curation; [S.W.W],[S.W.L],[N.A.D],[I.T], writing—original draft preparation; [S.W.W],[S.W.L],[N.A.D],[I.T], writing—review and editing; [S.W.W],[S.W.L],[N.A.D],[I.T], visualization; [S.W.W],[S.W.L],[N.A.D],[I.T], supervision project administration; [S.W.W],[S.W.L],[N.A.D],[I.T], funding acquisition; [S.W.W],[S.W.L],[N.A.D],[I.T], have read and agreed to the published version of the manuscript.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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