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APPLICATION OF APRIORIC ALGORITHM IN ORDERING PRINTING MATERIALS

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Abstract

Wendy Printing is one of the printers that collaborates with Labuhan Batu University, especially in the Computer Science faculty, Wendy's printing is located on the Jalan setia budi intersection of Labuhan Batu University campus. Wendy printing leaders and employees sometimes have difficulty knowing how many teaching materials are printed in one transaction, so that Wendy's printing leaders are still manual / speculative in printing teaching materials. The application of data mining for ordering teaching materials at the faculty of computer science at Labuhan Batu University in the wendy print can produce association rules that can be seen and analyzed for the results, so that the print leader can see the frequency of teaching materials that often occur in every transaction. Therefore, analysis and testing are carried out,

Keywords: Data Mining, Wendy's Printing, Apriori Algorithm, Association

1. Introduction

Percetakan Wendy is engaged in book printing and sales of stationery (stationery), which almost everyday prints teaching materials for female students. Labuhan Batu University, where the ordering system is still manual and of course, the pattern of consumer purchases every day is different, this needs to be further analyzed so that it can produce useful information that can be used in decision making and can support the business processes in the store and maximize the profits can be obtained.[1]

Data mining is a process of extracting data or filtering data by utilizing a large enough data set through a series of processes to obtain valuable information from that data. Data mining can be used by large companies to extract data to obtain information that can support and improve the company's business processes[2].

Apriori is an algorithm that is widely used to determine the pattern of relationships between products that are often purchased in a store or supermarket. This algorithm will provide suggestions for managers to carry out promotional strategies at supermarkets or stores they own. The mapping association rule generated by this algorithm is used to regulate placing the goods in a strategic place so that buyers will find it easier.[2][3]

2. Theoretical basis

2.1 Data Mining

Eko Prasetyo defines data mining as a process to get useful information from large database warehouses. [3][4]

[5]defining Data mining is the process of finding something meaningful from a new correlation, existing patterns and trends by sorting large data stored in repositories, using pattern recognition technology as well as mathematical and statistical techniques. The term data mining is sometimes also called Knowledge discovery .

2.1 *Association Rule*

Here are the steps for calculating association rules.[6][7]

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1) The system scans the database to get 1-itemset candidates (a set of items consisting of 1 item) and calculates the support value. Then the support value is compared with the minimum support that has been determined, if the value is greater than or equal to the minimum support, the itemset is included in the large itemset.
2) Itemset that are not included in the large itemset are not included in the next iteration and are pruned.
3) In the second iteration the system will use the results of the large itemset in the first iteration (L1) to form the second candidate itemset (L2). In the next iteration the system will use the results of the large itemset in the next iteration will use the results of the large itemset in the previous iteration (Lk-1) to form the following itemset candidate (Lk). The system will combine (join) Lk-1 with Lk-1 to get Lk, as in the previous iteration the system will prune the combination of itemset that is not included in the large itemset.
4) After the join operation is carried out, the new itemset pair resulting from the join process is calculated for support.
5) The candidate formation process, which consists of a join and prune process, will continue until the itemet candidate set is null, or no more candidates will be formed.
6) After that, from the results of the frequent itemset an association rule is formed that meets the predetermined values of support and confidence.
7) In the formation of the association rule, the same value is considered as one value.
8) *Association rule* formed must meet the predetermined minimum value.

Minimal Support: a value determined by the researcher to reduce the number of set item combinations to a minimum.[8][9]

Minimal Confidence is a value that is also determined by the researcher to reduce the combination of each k-item set (the result of trimming the minimum support) to form an association rule.

The basic methodology of association analysis is divided into two stages:

1) *Support*

Support of an association rule is the presentation of the combination of these items in the database, where if it has item A and item B then support is the proportion of transactions in the database containing A and B.

The support value of an item is obtained by the formula.

$$Support(A) = \frac{Jumlah\ transaksi\ mengandung\ A}{Total\ Transaksi}$$

While the support value of 2 items is obtained from the following formula:

$$Support(A,B) = P(A \cap B)$$

$$Support(A,B) = \frac{\sum Transaksi\ mengandung\ A\ dan\ B}{\sum Transaksi}$$

2) *Confidence*

Confidence of the association rule is a measure of the accuracy of a rule, namely the presentation of transactions in a database containing A and containing B.

$$Confidence = P(B|A) = \frac{\sum Transaksi\ mengandung\ A\ dan\ B}{\sum Transaksi\ mengandung\ A}$$

2.2 Apriori Algorithm

The Apriori Algorithm is an algorithm that performs frequent itemset searches using the association rule technique [4][6]The Apriori algorithm uses knowledge of previously known attribute frequencies to process further information. The Apriori algorithm determines which candidates may appear by paying attention to minimum support and minimum confidence. Support is the visitor value or the percentage of a combination of items in the database[10],[11]

broadly speaking, how the a priori algorithm works is:

1) The formation of the itemset candidate, the k-itemset candidate is formed from the (k-1) -itemset combination obtained from the previous iteration. One feature of the Apriori algorithm is the trimming of k-itemset candidates whose subsets containing k-1 items are not included in the high frequency pattern with length k-1.

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2) Support calculation for each k-itemset candidate. Support from each k-itemset candidate is obtained by scanning the database to calculate the number of transactions that contain all the items in the k-itemset candidate. This is also a feature of the Apriori algorithm where a calculation is required by scanning the entire database of the longest k-itemset.
3) Set a high frequency pattern. High frequency patterns containing k items or k-itemset are determined from k-itemset candidates whose support is greater than the minimum support.
4) If no new high frequency patterns are found then the whole process is terminated. If not, then add one k and return to part 1.

3. Results and Discussion

The data taken is sales transaction data in 2017. The data is data that represents the entire transaction data of 50 transactions.

Table 1. Book sales transaction data table

No.	*Items Purchased*
1	Introduction to Computer Science, Algorithms and Programming, Data Structures, Databases, Artificial Intelligence, Research Methods, Image Processing, Assembly Language
2	Algorithms and Programming, Data Structures, Artificial Intelligence, Expert Systems, Assembly Languages, Professional Ethics, Image Processing, Data Mining, Computer Security, Fuzzy Logic
3	Artificial Intelligence, Expert Systems, Data Mining, Image Processing, Professional Ethics, Fuzzy Logic, Web Programming, Data Structures
4	Web Programming, C ++ Programming Language, Professional Ethics, Fuzzy Logic, Artificial Intelligence, Data Structures, Expert Systems, Data Mining
5	Operations Research Engineering, Network Administration, Client / Server Programming, Web Programming
6	Data Mining, Introduction to Computer Science, Expert Systems, Data Structures, Professional Ethics, Image Processing, Computer Security, Assembly Language, Artificial Intelligence
7	Simulation Modeling, Entrepreneurship, Fuzzy Logic, Data Mining, Assembly Languages, Network Administration, Artificial Intelligence, Computer Security
8	Computer Security, Assembly Language, Research Methods, Information Systems
9	Project Management, Image Processing, Professional Ethics, Application Software, Mobile Programming, Simulation Modeling, Data Structures, Artificial Intelligence, Expert Systems, Assembly Languages, Data Mining, Computer Security, Fuzzy Logic
10	Data Mining, Fuzzy Logic, Assembly Language, Artificial Intelligence, Image Processing, Computer Security, Professional Ethics, Data Structures, Expert Systems
11	Information Systems, Application Software, Software Engineering, Network Administration, C ++ Programming Language, Client / Server Programming, Data Mining, Fuzzy Logic
12	Introduction to Computer Science, Data Structures, Artificial Intelligence, Research Methods, Fuzzy Logic, Expert Systems, Simulation Modeling, Professional Ethics
13	Introduction to Computer Architecture, Language and Automata Theory, Network Administration, Professional Ethics, Information Systems, Fuzzy Logic, Expert Systems, Artificial Intelligence, Data Structures, Data Mining
14	Data Structure, Mobile Programming, Image Processing, Introduction to Computer Architecture, Data Mining, Professional Ethics, Assembly Language, Fuzzy Logic,

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	Computer Security
15	Fuzzy Logic, Data Mining, Entrepreneurship, Assembly Language, Language and Automata Theory, Computer Security
16	Assembly Language, Expert System, Image Processing, Computer Security, C ++ Programming Language, Algorithm and Programming
17	Informatics Logic, Computer Networks, Artificial Intelligence, Professional Ethics, Computer Security, Fuzzy Logic, Expert Systems, Data Structures, Data Mining
18	Entrepreneurship, Language and Automata Theory, Artificial Intelligence, Operations Research Techniques, Mobile Programming, Professional Ethics
19	Expert Systems, Computer Security, Introduction to Computer Science, Computer Networks, Assembly Languages, Databases, Image Processing
20	Network Administration, Computer Security, Assembly Languages, Project Management, Web Programming
21	Simulation Modeling, Information Systems, Application Software, Client / Server Programming, Fuzzy Logic
22	C ++ Programming Language, Computer Networks, Operations Research Techniques, Entrepreneurship, Informatics Logic
23	Simulation and Project Techniques, Research Methods, Introduction to Computer Architecture, Databases
24	Data Mining, Assembly Languages, Artificial Intelligence, Project Management, Fuzzy Logic, Computer Security
	Web Programming, Assembly Language, Operations Research Techniques, Network Administration, Image Processing, Research Methods, Computer Security
25	Information Systems, Entrepreneurship, Assembly Language, C ++ Programming Language, Expert Systems, Artificial Intelligence, Image Processing, Computer Security
26	Computer Networks, Introduction to Computer Science, Professional Ethics, Data Mining, Mobile Programming, Expert Systems, Fuzzy Logic
27	C ++ Programming Language, Computer Security, Simulation Modeling, Assembly Language, Language Theory and Automata
	Information Systems, Language and Automata Theory, Informatics Logic, Artificial Intelligence
28	Application Software, Software Engineering, Operations Research Engineering, Network Administration
29	Assembly Languages, Mobile Programming, Simulation and Project Techniques, Databases, Data Structures
30	Web Programming, Network Administration, Expert Systems, Fuzzy Logic, Entrepreneurship, Operations Research Engineering, Image Processing, Assembly Language, Computer Security
31	Research Methods, Informatics Logic, Information Systems, Computer Security, Assembly Language
32	Data Structures, Professional Ethics, Expert Systems, Data Mining, Simulation Modeling, Project Management, Application Software, Fuzzy Logic, Image Processing
33	Professional Ethics, Database, C ++ Programming Language, Project Management, Image Processing, Expert Systems, Data Mining
34	Expert Systems, Image Processing, Information Systems, Computer Networks, Assembly Languages, Artificial Intelligence, Computer Security
	Project Management, Application Software, Expert Systems, Image Processing, Assembly Languages, Computer Security
35	Web Programming, Algorithms and Programming, Introduction to Computer

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	Science, Data Structures
36	Language and Automata Theory, Informatics Logic, Network Administration, Client / Server Programming, Data Mining, Fuzzy Logic
37	Professional Ethics, Simulation and Project Engineering, Software Engineering, Mobile Programming, Simulation Modeling, Expert Systems, Data Mining, Fuzzy Logic
38	Mobile Programming, Client / Server Programming, Simulation Modeling, Assembly Language, Informatics Logic
39	Databases, Information Systems, Professional Ethics, Expert Systems, Artificial Intelligence, Entrepreneurship, Assembly Language, Research Methods, Image Processing, Data Mining, Computer Security
40	Software Engineering, Data Structures, Algorithms and Programming, Mobile Programming, Network Administration
41	Operations Research Techniques, Assembly Language, Language and Automata Theory, Expert Systems, Image Processing, Project Management
42	Data Mining, Entrepreneurship, Mobile Programming
	Network Administration, Professional Ethics, Project Management, Software Engineering, Expert Systems, Data Mining
	Expert Systems, Image Processing, Client / Server Programming, Computer Security, Fuzzy Logic, Web Programming, Assembly Language
	Web Programming, Professional Ethics, Assembly Language, Introduction to Computer Science, Computer Networks, Expert Systems, Data Mining
	Data Mining, Computer Security
	Project Simulation Techniques, Web Programming, Data Mining, Computer Networks, Informatics Logic

Suppose a minimum support value ≥ 15% is given from 50 transactions and then a search for the support value for each item is carried out using the formula. The support value of an item is obtained by the following formula.

$$\text{Support (A)} = \frac{\text{The number of transactions containing A.}}{\text{(Total Transactions)}}$$

Example :
Support (Introduction to Computer Science) = 7/50 = 14%
Step 1:
Look for C1 (1-itemset candidate) as follows:

Table 2. 1-itemset (k1) candidate

No.	*List of Teaching Materials*	*amount*	*Support%*
1	Introduction to Computer Science	7/50 = 0.14	14%
2	Algorithms and Programming	5/50 = 0.1	10%
3	Logic Informatics	7/50 = 0.14	14%
4	Data Structure	15/50 = 0.3	30%
5	Software engineering	5/50 = 0.1	10%
6	Database	6/50 = 0.12	12%
7	Computer network	7/50 = 0.14	14%
8	Artificial intelligence	17/50 = 0.34	34%
9	Project management	8/50 = 0.16	16%
10	Simulation and Project Engineering	4/50 = 0.08	8%
11	Research methods	7/50 = 0.14	14%

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12	Information Systems	9/50 = 0.18	18%
13	Image processing	19/50 = 0.38	38%
14	Expert system	24/50 = 0.48	48%
15	Web Programming	10/50 = 0.2	20%
16	Mobile Programming	9/50 = 0.18	18%
17	Professional ethics	18/50 = 0.36	36%
18	Application Software	6/50 = 0.12	12%
19	C ++ Programming Language	7/50 = 0.14	14%
20	Introduction to Computer Architecture	3/50 = 0.06	6%
21	Operations Research Techniques	7/50 = 0.14	14%
22	Language and Automata Theory	7/50 = 0.14	14%
23	Network Administration	11/50 = 0.22	22%
24	Client / Server Programming	6/50 = 0.12	12%
25	Data Mining	24/50 = 0.48	48%
26	Computer Security	23/50 = 0.46	46%
27	Simulation Modeling	8/50 = 0.16	16%
28	Fuzzy Logic	20/50 = 0.4	40%
29	Entrepreneurship	8/50 = 0.16	16
30	Assembly Language	26/50 = 0.52	52%

Step 2:
Based on the table that contains items with the support they have, then look for L1 = {large 1-itemset} by selecting items that meet the minimum support value ≥ 15% as follows.

Table 3. Value Support

No.	*List of Teaching Materials*	*amount*	*Support%*
1	Network Administration	11/50 = 0.22	22%
2	Assembly Language	26/50 = 0.52	52%
3	Data Mining	24/50 = 0.48	48%
4	Professional ethics	18/50 = 0.36	36%
5	Artificial intelligence	17/50 = 0.34	34%
6	Computer Security	23/50 = 0.46	46%
7	Entrepreneurship	8/50 = 0.16	16%
8	Project management	8/50 = 0.16	16%
9	Fuzzy Logic	20/50 = 0.4	40%
10	Image processing	19/50 = 0.38	38%
11	Mobile Programming	9/50 = 0.18	18%
12	Simulation Modeling	8/50 = 0.16	16%
13	Data Structure	15/50 = 0.3	30%
14	Information Systems	9/50 = 0.18	18%
15	Expert system	24/50 = 0.48	48%
16	Web Programming	10/50 = 0.2	20%

Furthermore, if the minimum confidence value is 50%, the association rules that are formed are as follows:

Table 4. Minimum Suppott Value

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No.	*List of Teaching Materials*	*amount*	*Support%*
1	Assembly Language, Computer Security Assembly Language, Image Processing	21/26 = 0.8077	80.77%
2	Assembly Language, Expert System Data Mining, Professional Ethics	16/26 = 0.6154	61.54%
3	Data Mining, Fuzzy Logic Data Mining, Expert System	14/26 = 0.5358	53.58%
4	Professional Ethics, Data Mining	16/24 = 0.6667	66.67%
5	Professional Ethics, Artificial Intelligence	16/24 = 0.6667	66.67%
6	Professional Ethics, Fuzzy Logic	15/24 = 0.625	62.5%
7	Professional Ethics, Image Processing	16/18 = 0.8889	88.89%
8	Professional Ethics, Data Structure Professional Ethics, Expert System	11/18 = 0.6111	61.11%
9	Artificial Intelligence, Assembly Language	12/18 = 0.6667	66.67%
10	Artificial Intelligence, Data Mining Artificial Intelligence, Professional Ethics	9/18 = 0.50	50%
11	Artificial Intelligence, Computer Security	11/18 = 0.6111	61.11%
12	Artificial Intelligence, Fuzzy Logic	16/18 = 0.8889	88.89%
13	Artificial intelligence, Image processing	10/17 = 0.5882	58.82%
14	Artificial intelligence, Data Structure	11/17 = 0.6471	64.71%
15	Artificial Intelligence, Expert System	11/17 = 0.6471	64.71%
16	Computer Security, Assembly Language Computer Security, Image Processing	10/17 = 0.5882	58.82%
17	Computer Security, Expert System Entrepreneurship, Assembly Language	10/17 = 0.5882	58.82%
18	Entrepreneurship, Data Mining Entrepreneurship, Artificial Intelligence	9/17 = 0.5294	52.94%
19	Entrepreneurship, Computer Security Fuzzy Logic, Data Mining	10/17 = 0.5882	58.82%
20	Fuzzy Logic, Professional Ethics Fuzzy Logic, Artificial Intelligence	12/17 = 0.7059	70.59%
21	Fuzzy Logic, Computer Security Fuzzy Logic, Data Structure	21/23 = 0.913	91.3%
22	Fuzzy Logic, Expert System Project Management, Assembly Language	14/23 = 0.6087	60.87%
23	Project Management, Data Mining Project Management, Professional Ethics	13/23 = 0.5652	56.52%
24	Project management, Computer Security	5/8 = 0.625	62.5%
2526	Project Management, Image Processing Project Management, Expert System	4/8 = 0.50 4/8 = 0.50	50% 50%
27	Image Processing, Assembly Language Image processing,	5/8 = 0.625	62.5%
28	Computer Security		
29	Image Processing, Expert System	16/20 = 0.80	80%
30	Mobile Programming, Data Mining Mobile Programming, Professional Ethics	12/20 = 0.60 10/20 = 0.50	60% 50%

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31	Simulation Modeling, Assembly Language		
	Simulation Modeling, Data Mining	10/20 = 0.50	50%
32	Simulation Modeling, Professional Ethics		
33	Simulation Modeling, Fuzzy Logic	10/20 = 0.50	50%
34	Simulation Modeling, Expert System	13/20 = 0.65	65%
	Data Structure, Data Mining	5/8 = 0.625	62.5%
35	Data Structure, Professional Ethics		
	Data Structure, Artificial Intelligence	5/8 = 0.625	62.5%
36	Data Structures, Fuzzy Logic		
	Data Structure, Image Processing	4/8 = 0.50	50%
37	Data Structure, Expert System		
	Information Systems, Assembly Language	4/8 = 0.50	50%
38	Information Systems,		
	Artificial intelligence	5/8 = 0.625	62.5%
39	Information Systems,		
	Computer Security	6/8 = 0.75	75%
40	Expert System, Assembly Language		
	Expert System, Data Mining	16/19 = 0.8421	84.21%
41	Expert System, Professional Ethics		
	Expert System, Artificial Intelligence	14/19 = 0.7368	73.68%
42	Expert System, Computer Security		
		16/19 = 0.8421	84.21%
43			
		5/9 = 0.5556	55.56%
44			
		5/9 = 0.5556	55.56%
45			
		4/8 = 0.50	50%
46			
		4/8 = 0.50	50%
47			
		4/8 = 0.50	50%
48			
		6/8 = 0.75	75%
49			
		4/8 = 0.50	50%
50			
51		10/15 = 0.6667	66.67%
52		11/15 = 0.7333	73.33%
		10/15 = 0.6667	66.67%
53			
54		10/15 = 0.6667	66.67%
		8/15 = 0.5333	53.33%
55			
56		10/15 = 0.6667	66.67%
		5/9 = 0.5556	55.56%
57			
		5/9 = 0.5556	55.56%
58			
		5/9 = 0.5556	55.56%
59			

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60		14/24 = 0.5833	58.33%
61		15/24 = 0.625	62.5%
62		16/24 = 0.6667	66.67%
63		12/24 = 0.50	50%
		13/24 = 0.5417	54.17%

From the steps that have been carried out above, the items that meet the greatest Support x Confidence and minimum confidence ≥50% so that the association rules are sequential.

Table 5. Association Rules

No.	*Association Rules*
1	If you buy Assembled Language teaching materials, you will buy Computer Security with 80.77% confidence If you buy Project Management teaching materials, you will buy Data Mining with 62.5% confidence
2	If you buy Project Management teaching materials, you will buy Professional Ethics with 50% confidence If you buy Project Management teaching materials, you will buy Computer Security with 50% confidence
3	If you buy Project Management teaching materials, you will buy Image Processing with 62.5% confidence
4	If you buy Project Management teaching materials, you will buy an Expert System with 75% confidence If you buy Image Processing teaching materials, you will buy Assembled Language with 84.21% confidence
5	If you buy Image Processing teaching materials, you will buy Computer Security with 73.68% confidence If you buy Image Processing teaching materials, you will buy an Expert System with 84.21% confidence
6	If you buy Mobile Programming teaching materials, you will buy Data Mining with 55.56% confidence If you buy Mobile Programming teaching materials, you will buy Professional Ethics with 55.56% confidence
7	If you buy Simulation Modeling teaching materials, you will buy Assembly Language with 50% confidence If you buy Simulation Modeling teaching materials, you will buy Data Mining with 50% confidence
8	If you buy Simulation Modeling teaching materials, you will buy Professional Ethics with 50% confidence If you buy Simulation Modeling teaching materials, you will buy Fuzzy Logic with 50% confidence
9	If you buy Simulation Modeling teaching materials, you will buy an Expert System with 50% confidence If you buy Data Structure teaching materials, you will buy Data Mining with 66.67% confidence
10	If you buy Data Structure teaching materials, you will buy Professional Ethics with 73.33% confidence

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	If you buy Data Structure teaching materials, you will buy Artificial Intelligence with 66.67% confidence
11	If you buy Data Structure teaching materials, you will buy Fuzzy Logic with 66.67% confidence
12	If you buy Data Structure teaching materials, you will buy Image Processing with 53.33% confidence
	If you buy Data Structure teaching materials, you will buy an Expert System with 66.67% confidence
13	If you buy Information Systems teaching materials, you will buy Assembled Language with 55.56% confidence
	If you buy Information Systems teaching materials, you will buy Artificial Intelligence with 55.56% confidence
14	If you buy Information Systems teaching materials, you will buy Computer Security with 55.56% confidence
	If you buy Expert System teaching materials, you will buy Assembled Language with 58.33% confidence
15	If you buy Expert System teaching materials, you will buy Data Mining with 62.5% confidence
	If you buy Expert System teaching materials, you will buy Professional Ethics with 66.67% confidence
16	If you buy Expert System teaching materials, you will buy Artificial Intelligence with 50% confidence
	If you buy Expert System teaching materials, you will buy Computer Security with 54.17% confidence
17	If you buy Expert System teaching materials, you will buy Fuzzy Logic with 54.17% confidence
18	If you buy Expert System teaching materials, you will buy Image Processing with 66.67% confidence
19	If you buy Web Programming teaching materials, you will buy Assembly Language with 50% confidence
20	If you buy Web Programming teaching materials, you will buy an Expert System with 50% confidence

3.2. System Design

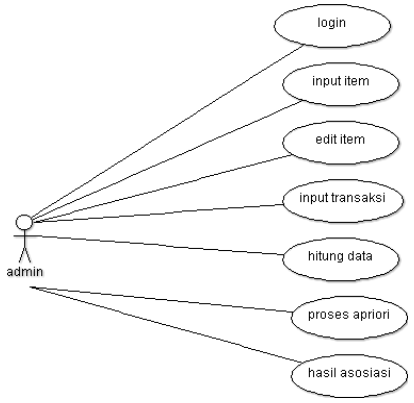

Figure 1. Use Case Diagram

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Discussion

After going through the steps previously described, starting from logging in to hiIf the results of the transaction are not obtained, it can be concluded that the system that has been built is as expected, namely:

a. Consumers (students / i) no longer need to waste time looking for or photocopying the required textbooks. Consumers (students) only need to come to the recommended shop, namely the Wendy printing shop to order the necessary books.
b. Consumer (student / i) no longer pay more expensive, because there is already a set price between the Faculty of Computer Science and the printing shop, so the price is relatively more affordable for students.

4. Conclusion

After testing the system that has been built, namely Application of Data Mining for Ordering Teaching Materials Printing at the Faculty of Computer Science, Labuhan Batu University at Wendy's Printing Using the Apriori Algorithm, the following conclusions can be obtained:

1. The Apriori Algorithm is a type of association algorithm in data mining that performs data retrieval to determine association rules through the Frenquent itemset of a combination of items.
2. With this research system, the processing and data retrieval process becomes more efficient, and the knowledge obtained in the form of association rules can be used to determine the next layout.
3. Can find out the teaching materials that are often purchased by consumers at the same time.
4. Can be used as a tool to minimize the mistakes of the Wendy printing party in knowing the relationship between teaching materials purchased by consumers and improving customer service.

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