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IDENTIFICATION OF THE NOTE PATTERN FROM BALUNGAN GENDING LANCARAN USING APRIORI ALGORITHM

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ABSTRACT

The note pattern of balungan gending can be used as a parameter reference in creating the gending made by the Javanese gamelan. A number of gending lancaran is used as sample of the experiment and notation as a dataset. The analysis is done by using apriori algorithm, because it can search for the similarity in attribute in a data. The complexity of time is a testing standard of an algorithm to obtain an efficient execution of time, the approach of an asymptotic analysis using the big-O concept is one of the techniques which are usually applied to test the complexity of an algorithm. This research analyse the complexity of time in the algorithm that is used to identify the note pair pattern of the gending lancaran.

Keywords: *Gamelan, Apriori, Complexity*

1. INTRODUCTION

The gamelan is a traditional music equipment of the original Indonesian cultural heritage. A set of gamelan consisting of various instruments which comprises of kendang, bonang, the continuation of bonang, demung, saron, peking, kenong and kethuk, slenthem, gender, gong, gambang, rebab, zither and flute. The gamelan instruments are presented in a set of the Javanese art which is known as Karawitan [1]. Rahayu Supanggah in Supardi article [2] states that the Javanese karawitan musical composition is called gending. In karawitan art, a rawit player must have the ability to play the gending properly and clearly. Proper means able to play the gending according to rules, norms, habits, traditions and esthetical taste. While clearly means the rawit player must be able to play the gending technically and ethically in the instrument application according to standard

The gending made by the gamelan has its own characteristics which represents the life of the Javanese society. The composer must understand the cosmology concept of the Javanese people, the norms and rules which are sacred, harmonious behaviour, self control one to another and the dynamical rhythms of the life of the Javanese people [3][4][8]. According to Syarif and Hastuti [1], if the gending represents the pattern of the life of the Javanese people, then the series of notation in the gending has a pattern and structure which also represents the life of the Javanese people.

According to Supardi [2] there are 16 gending structures which are lancaran, srepegan, sampak, ayak-ayakan kemuda, ketawang, ladrang, merong kethuk 2 kerep, merong kethuk 2 arang, merong kethuk 4 kerep, merong kethuk 4 arang, merong kethuk 8 kerep, Inggah kethuk 2, Inggah kethuk 4, Inggah kethuk 8, and Inggah kethuk 16. The structure of the gending lancaran has a feature which is the number of balungan whips/knocks, in one line there are 16 balungan whips/knocks, one line consists of 4 gatras, every gatra consists of 4 knocks with the details of first and third knocks are for kethuks, the second even knock is for kempul, the fourth knock is for kenong. The fourth last gatra knock is the gong.

The balungan/gending notation is represented in in the form of numbers, therefore it can be analyzed mathematically to identify its pattern. The analysis is conducted by using apriori algorithm, as it is able to search the attribute similarity in a data. The pattern of the balungan gending notation can be used as a parameter reference in creating gending. A number of gending lancaran is used as a research sample. The notation in every gending sample can be made as a dataset, and shown in a tabular format to be analyzed for searching the similarity of attribute based on the association rules to identify

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the pattern. Table 1 shows the notation example of the balungan gending lancaran.

Table 1. Notation Of Balungan Gending Lancaran

Gending lancaran	Gatra 1	Gatra 2	Gatra 3	Gatra 4
Tropongbang	3 1 3 2	3 1 3 2	5 6 1 2	1 6 3 5
Suwe Ora Jamu	2 3 2 3	1 2 3 2	3 5 6 5	4 2 1 6
Sayuk-sayuk	5 6 5 6	2 3 6 5	2 3 2 3	6 1 3 2
Salake	5 6 2 1	5 6 2 1	3 5 3 2	3 1 6 5
Ana tamu	5 6 5 6	3 2 1 6	3 5 6 5	2 3 5 3
Gugur gunung	6 7 6 7	3 5 7 6	2 7 2 7	6 5 3 2
Jago Kluruk	1 6 1 5	2 5 3 2	3 5 3 2	3 2 1 6
Gajah-gajah	6 7 5 6	2 7 5 3	5 6 5 3	5 3 5 6
Kebo giro	6 5 3 2	3 2 6 5	6 5 3 2	3 2 6 5
Kembang Jeruk	3 2 3 5	3 6 3 2	3 2 3 5	3 6 3 2
Jaran Teji	2 1 2 1	6 5 2 1	3 5 6 3	2 3 2 1
Gundul Pacul	3 5 6 7	2 3 2 7	3 5 7 6	7 6 5 3
Kembang Mlati	3 5 6 1	6 2 6 1	3 5 6 1	3 2 1 6
Kuda Nyongklang	2 3 2 6	2 3 2 7	3 2 6 5	3 5 6 1
Kuning-kuning	2 1 2 1	2 1 2 1	2 1 2 1	2 1 3 5
Nyoto Kowe Wasis	6 3 6 7	6 5 3 2	5 6 5 6	2 3 5 6

The identification of the balungan gending lancaran is needed to know the characteristics of the gending lancaran pattern which is normally used in the gending lancaran composition. The analysis is conducted to search for the similarities of the attributes between pairs of notation, and providing weight based on the domination frequency of the pairs of notation. The analysis is conducted by using the apriori algorhithm, because it can be used properly to search for the similarity of attributes in a data. The method in the analysis of similarity, which is also known as the market basket analysis, is searching to reveal the association among attributes, and therefore the search is made to reveal the rules for measuring the relationship between two attributes or more [5].

This research focuses to the identification of the balungan gending lancaran notation by using apriori algorithm and calculating the complexity of the algorithm by using the asymptotic notation. The complexity of algorithm is needed to test the time, memory and other sources which is needed by an algorithm to solve computing problem [6] through several approaches, one of them is by using the asymptotic notation or the Big-O notation.

2. LITERATURE REVIEW

A. Algoritma Apriori

The association rules [5], the analysis of similarity (affinity) is a study of attribute or a series of characteristics. The similarity analysis method, also known as the market basket analysis is to search and reveal the association between the attributes. It is therefore, the search is made to find out the rules for measuring the relationship between two attributes or more.

The market basket data type is represented in two basic methods, namely in a transactional data format or a tabular data format. The transactional data format only uses two fields which are the ID and content, every record represent an item. While in the tabular data format, each record can represent separate transaction, with the number of field flags 0/1 as many as the items.

Support for a certain association rule A to B is the proportion from the transaction in D which contains A and B, and therefore:

$$support = P(A \cap B) = \frac{jumlah\ transaksi\ A\ dan\ B}{jumlah\ total\ transaksi}$$

Confidence c from the association rules A to B is used to measure the accuracy of the rules , as what has been decided with a transaction percentage in D which covers A and also B:

$$confidence = P(B|A) = \frac{p(A \cap B)}{p(A)} = \frac{jumlah\ transaksi\ A\ dan\ B}{jumlah\ transaksi\ A}$$

A number of gending lancaran is used as a sample of experiment. The notation in each gending sample is made as a dataset, and shown in a tabular format to be analyzed to look for the similarity of attribute based on the association rules to identify the pattern. The pattern of identification is made by using the procedure in the apriori algorithm, applied in all the gendings, deciding for candidate I, candidate II, the calculation of support, finding the confidence candidate, calculation of confidence and the support X confidence. The determination of the itemset in the transaction is done by mapping every song notation twice, the first and second notes become the first pair, the second and third notes

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become the second pair, the third and fourth notes become the third pair, and so forth. Each pair represents one transaction activity. Thus, *I1* (the first notation pair) = *T1* (the first transaction), *I2* = *T2*, *I3* = *T3*, and so forth.

$$I(n) = T(n)$$

Where:

I = notation pair

T = transaction

In the Kebo Giro gending, there are eight pairs of tones, which means eight transactions. The first transaction is item 6 5 (*I1*), the second transaction is item 3 2 (*I2*), the third transaction is 3 2 (*I3*) and so forth.

The process is continued by searching for the candidate from the itemset. After the candidate is found, then the support value will be calculated. The support for a certain association rule A to B is a proportion from the transaction containing A and B as in the equal transaction of formula 1 data format and tabular data shown in table 2.

Table 2 Kebo Giro Gending Balungan Notation In The Data Transaction Format

Transaksi ID	Item		Transaksi ID	Item	
1	6	5	11	6	7
2	3	2	12	6	5
3	3	2	13	6	5
4	6	5	14	6	7
5	6	5	15	6	7
6	3	2	16	6	5
7	3	2	17	7	6
8	6	5	18	3	2
9	6	5	19	3	2
10	6	7	20	6	5

Table 3 shows the Kebo Giro Gending Balungan in the tabular data format.

Tabel 3. Kebo Giro Gending Balungan Notation In Tabular Data Format

Transaksi ID	1	2	3	4	5	6	7
1	0	0	0	0	1	1	0
2	0	1	1	0	0	0	0
3	0	1	1	0	0	0	0
4	0	0	0	0	1	1	0
5	0	0	0	0	1	1	0
6	0	1	1	0	0	0	0
7	0	1	1	0	0	0	0
8	0	0	0	0	1	1	0
9	0	0	0	0	1	1	0
10	0	0	0	0	0	1	1
11	0	0	0	0	0	1	1
12	0	0	0	0	1	1	0
13	0	0	0	0	1	1	0
14	0	0	0	0	0	1	1
15	0	0	0	0	0	1	1
16	0	0	0	0	1	1	0
17	0	0	0	0	0	1	1
18	0	1	1	0	0	0	0
19	0	1	1	0	0	0	0
20	0	0	0	0	1	1	0
Jumlah	0	6	6	0	9	14	5

(3)

The improvisation in searching for the confidence value [1] increases on finding new candidates after the calculation of support, or called as the search for the confidence candidate. The confidence candidate calculates the number of transactions of A and B, which fits with the notation in the gending. Condition that, if it is A, therefore B, and the opposite, if it is B, therefore it is A, does not apply for the notation.

The addition of the confidence candidate feature, which is by adding the calculation of the suitable itemset frequency based on the sequence of the tunes divided by the total number of tunes in the gending, can make the confidence calculation, become more accurate. The search for the confidence candidate is conducted based on the suitable itemset frequency, which is then based on the sequence of tunes obtained from:

- Transaction = the total transaction
- Itemset = the selected itemset based on the frequency
- In = the sequence of tunes in the mapped gending in pairs
- Ftn = the suitable itemset frequency with sequence of tunes in the gending

```
for (i=0; i<transaksi; i++)
{
        if(itemset[i] == In[i])
        {
           FTn[i]) += 1;
        }
};
```

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Further, the itemset frequency which is suitable with the sequence of tunes in the gending is divided with the total tunes in the gending (Ftn/Tg).The total tunes is acquired from the total transaction multiplied by two, since the tunes in the gending are mapped in the pair format (2 tunes). Accordingly the confidence candidate formula (CC) is:

$$CC = \frac{FTn}{Tg} \qquad (5)$$

Thus the improvisation of finding the value confidence is by adding the new candidate after the support process can limit the trivial rules, by constantly calculating the frequency of every item based on the tunes sequence:

$$confidence = P(B|A) = \frac{p(A \cap B)}{p(A)} \; x \; CC$$

The Search for Kebo Giro Candidate

Based on the table 3 data, further searching F1, that is the frequent itemset. If ϕ = 1, thus the frequent itemset is the one that occurs more than 1(candidate). Then the itemset F1=2, 3, 5, 6, 7 which is shown in table 4.

Table 4. The Frequent Kebo Giro Itemset (Candidate I)

Itemset	F_1
2	6
3	6
5	9
6	14
7	5

The Search For Gending Kebo Giro Candidate II

Next step is to search the frequent two itemset (F2), that is {{23}, {56}{67}} as shown in table 5.

Table 5. 2-Itemset Kebo Giro

Nada	F_2	Nada	F_2
23	**6**	36	0
25	0	37	0
26	0	**56**	**9**
27	0	57	0
35	0	**67**	**5**

Table 6. The Frequent 2-Itemset Kebo Giro (Candidate II)

Itemset	F2
23	6
56	9
67	5

Calculating The Gending Kebo Giro Support

The analysis has produced the 2-itemset Gending Kebo Giro. Next is to calculate the support for every candidate II. Table 7 shows the results of the calculation of support for the itemset.

Tabel 8. Results Of Gending Kebo Giro Candidate II Support

Itemset	Frekuensi	Total Transaksi	Support (F/T)
23	6	20	30%
32	6	20	30%
56	9	20	45%
65	9	20	45%
67	5	20	25%
76	5	20	25%

The Search of Gending Kebo Giro Confidence Candidate

Table 9 presents the confidence candidate itemset. As ϕ = 1, then the confidence candidate obtained is the one which has a frequency of more than 1 as shown in table 10.

Table 9 Kebo Giro Itemset Confidence Candidate

Itemset	FTn	Tg	CC (FTn/Tg)
23	0	40	0
32	6	40	15%
56	0	40	0
65	9	40	22,5%
67	4	40	10%
76	1	40	2,5%

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Table 10 The Kebo Giro Frequent Confidence Candidate

Itemset	FTn	Tg	CC (FTn/Tg)
32	6	40	15%
65	9	40	22,5%
67	4	40	10%
76	1	40	2,5%

Calculating the Gending Kebo Giro Confidence
Next step is calculating the confidence for the itemset which has been determined in the confidence candidate. Table 11 shows the results of the confidence itemset calculation.

Table 11 Results Of Kebo Giro Confidence

Itemset	Frekuensi		(A ∩ B)/A	CC	Confidence
	A ∩ B	A			
32	6	6	100%	15 %	15%
65	9	14	64,3%	22,5 %	14,46%
67	5	14	35,7%	10 %	3,57%
76	5	5	100%	2,5 %	2,5%

Support X Gending Kebo Giro Confidence
Further is to determine *support X Confidence*, presented in table 12.

Table 12 Kebo Giro Support X Confidence Results

Itemset	Support (s)	Confidence ©	S x c
32	30%	15%	0,045
65	45%	14,46%	0,065
67	25%	3,57%	0,009
76	25%	2,5%	0,006

Analysis of Balungan Gending Kebo Giro repeating pattern of the notation pair
The following step is to analyze the Balungan Kebo Giro repeating pattern of the notation pair, shown in table 13.

Table 13. The Balungan Kebo Giro Repeating Pattern Of The Notation Pair In A Tabular Data Format

Transaksi ID	65	32	67	76	N
1	1	0	0	0	0
2	0	1	0	0	1
3	0	1	0	0	0
4	1	0	0	0	1
5	1	0	0	0	0
6	0	1	0	0	1
7	0	1	0	0	0
8	1	0	0	0	1
9	1	0	0	0	0
10	0	0	1	0	1
11	0	0	1	0	0
12	1	0	0	0	1
13	1	0	0	0	0
14	0	0	1	0	1
15	0	0	1	0	0
16	1	0	0	0	0
17	0	0	0	1	0
18	0	1	0	0	1
19	0	1	0	0	0
20	1	0	0	0	0

Based on table 13 above, the repeating pattern of the notation pair of the Balungan Gending Kebo Giro is 0,1,0,1,0,1,0,1,0,1,0,1,0,1,0,0,0,1,0,0,0,1,0,0.

B. Asymptotic Time Complexity
An algorithm must not only correct, but also efficient [7]. Effective algorithm is an algorithm that minimizes needs time and space. Big-O notation is that if an algorithm has asymptotic time O (f (n)), if n is made to be large, the time required will never exceed a constant C multiplied by f (n). thus, f (n) is an upper bound of T (n) for large *n*..

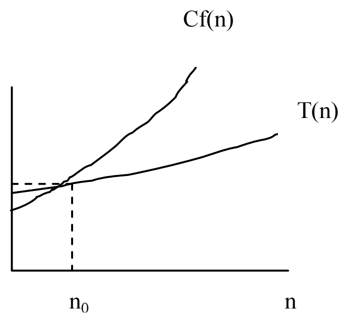

Figure 1. Big-O Ilustration

This research is done to identify the notation pattern of the balungan gending lancaran using the apriori algorithm and to analyze the algorithm complexity applying the Big-O approach.

II. DISCUSSION

A. Primitive Operation Analysis

This section discusses how each algorithm's time complexity is calculated using the asymptotic approach to analysis with the help of Big-O notation.

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```
1  kandidat2 = new Array();
2  deret_pasangan = new Array();
3
4  for (i=0; i<transaksi; i++)
5  {
6              deret_pasangan[i] =
7              (deret_gendhing[i*2]*10)+deret_gendhing[i*2+1];
8              deret_pasangan.sort();
9  }
10
11 for (i=0; i<transaksi; i++)
12             {
13             if (deret_pasangan[i+1] != deret_pasangan[i])
14                         {
15                         kandidat2.push(deret_pasangan[i]);
16                         }
17             }
18 jumlah_pasangan_terpakai = kandidat2.length;
19
20 confidence_pasangan = new Array();
21 for (i=0; i<jumlah_pasangan_terpakai; i++)
22             {
23             confidence_pasangan[i] = 0;
24             }
25
26 not_genap = new Array();
27 for (i=0; i<jumlah_pasangan_terpakai; i++)
28             {
29             not_genap[i] = Math.floor(kandidat2[i]/10);
30             }
31 n_pasangan = 0;
32
33 totalA = new Array();
34 for (i=0; i<jumlah_pasangan_terpakai; i++)
35     {
36     totalA[i] = 0;
37     }
38
39 while (n_pasangan<jumlah_pasangan_terpakai)
40     {
41     for (i=0; i<7; i++)
42     {
42         if (not_genap[n_pasangan] == deret_not[i])
43         {
44             totalA[n_pasangan] = distribusi_not_akhir[i];
45         }
46  }
47     n_pasangan++;
48     }
```

Figure 2. Implementation Apriori Algorithm

Figure 2 is an algorithm used to find pairs of tones, do the sorting order of the pair of tones, dispose the same tones pair, looking for a number of pairs of tones, and find the number of distribution of pairs of tones.

In line (1) and (2) show the array declaration deret_pasangan and kandidat2. So the time complexity owned by line (1) and line (2) respectively is O(n).

Line (4) to (25) are looping performed to looking for pair of tones are used. Tones do not read as unity, but per pair. Thus the tones (2 3) do not read 2 and 3, but (2 3) twenty-three. The time complexity owned on the line each valued O (n). Pair of tones are sorted to to obtain pair of tones ascendingly. Thus, the complexity of the time is O(n).

The next pair of tones, in this case the same confidence_pasangan dis iscarded, in order to obtain kandidat2 or pair of tones .The resulting time complexity is equal to O(n). Finding the total number of pairs of used tones, so that the resulting complexity of the time in algorithm is equal to O(n).

Next is to look for the amount of support to calculates the number of pair of tones distribution by using a while loop command. The resulting time complexity is equal to $O(n^2)$.

Thus, the total time complexity owned by the above algorithm for is $O(n) + O(n) + O(n) + O(n) + O(n^2) = O(n^2)$.

3. CONCLUSION

Based on the the experimental results, the balungan notation pattern can be used as a parameter reference in creating the gending which is made by the Javanese gamelan. The complexity of using the asymptotic analysis approach by using the Big-O concept shows that the algorithm complexity is O(n2).

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