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Applying Data Mining to Classify Customer Satisfaction using C4.5 Algorithm Decision Tree

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Abstrak

Dengan ketatnya persaingan didalam dunia bisnis menuntut para pelaku usaha agar dapat cepat dan tanggap dalam mengambil sebuah kepututusan agar usaha yang didirikan dapat tetap bertahan ditengah sistuasi yang sekarang terjadi. Salah satu bisnis yang populer adalah bisnis makanan khususnya pembukaan cafe yang terjadi pada setiap tahunnya. Salah satu cafe yang diminati oleh pelanggan adalah cafe yang berkonsep modern, pelayanan yang ramah, dan harga terjangkau oleh masyarakat. The Finn Coffee adalah cafe yang menyediakan berbagai jenis minuman dan makanan, terutama berbagai jenis minuman kopi. Kepuasan pelanggan adalah definisi dari perasaan seseorang saat melakukan perbandingan terhadap kinerja seseorang atau Kepuasan merupakan sebuah tanggapan pelanggan terhadap kebutuhan mereka yang telah terpenuhi. Kepuasan sendiri merupakan suatu suatu ekspresi perasaan senang yang dialami oleh seseorang setelah menerina produk yang dia inginkan dengan harga dan kualitas yang baik serta layanan yang memuaskan. Penelitian ini bertujuan untuk Untuk menganalisis kepuasan pelanggan yang datang berkunjung ke cafe menggunakan algoritma C4.5 dengan mengunakan kriteria-kriteria yang telah ditentukan sebelumnya. Klasifikasi kepuasan pelanggan menggunakan algoritma C4.5, dimana algoritma ini akan membantu melihat tingkat kepuasan pelanggan yang datang mengunjungi cafe dengan cara menjawab google Form yang telah dibagikan oleh pegawai/owner cafe.

Kata Kunci*— Kepuasan Pelanggan, Klasifikasi, Algoritma C4.5*

Abstract

Tight business competition demands business actors to make responsive, timely decisions to survive the uncertainty. Food business, especially cafes, has emerged as one of the most popular business types recently. One cafe concept that draws most customers' interest is modern concepts, friendly service, and affordable prices. Finn Coffee is one of the cafes providing a range of foods and beverages, especially coffee-based beverages. Customer satisfaction defines one's feelings when comparing performance. It denotes customer's responses to their satisfied needs. The term satisfaction itself is described as one's happy expression after receiving a quality product with affordable price and satisfying quality. The present study aimed to analyze cafe customer satisfaction using the C4.5 algorithm with predetermined criteria. Customer satisfaction was classified using C4.5. The algorithm displays the level of customer satisfaction based on the customers' response to the Google form distributed by the cafe employees/owner.

Keywords*— Satisfied Customer, Classify, C4.5 Algorithm*

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1. INTRODUCTION

Technology development helps individuals process thousand or even millions of data. As technology continues to develop, it is increasingly important in analyzing customer satisfaction[1]. Customer satisfaction represents data owned by a company related to its customer[2]. It plays a strategic role in developing a business promotion. A satisfied customer may indirectly promote the business through word-of-mouth, helping business/ company owners solve marketing problems[3]. The cafe is one of the businesses that heavily rely on customer satisfaction[4]. Recently, Indonesian youth have spent more time in the cafe for various reasons, from simply relaxing to discussing school assignments[5]. This trend should encourage cafe owners to improve their customer satisfaction by providing a comfortable cafe atmosphere, delicious foods and beverages, and satisfying services from cafe employees, among others[6].

The C4.5 algorithm has been used to predict online customer satisfaction [7] using fourteen attributes. The data obtained in this study originated from online questionnaire responses stored in the Population and Civil Registration Office database, consisting of fifty public data presented in CSV format[8]. In this study, the data were analyzed using rapid miner version 5.3.000[9]. The study developed three rules in data processing using the C4.5 algorithm. These rules are the final result of the decision tree[10]. In the previous study [11] the algorithm is capable of predicting students' graduation. The study applied C4.5 Algorithm to predict students' graduation. It is one of the frequently-used classification tree algorithms because of its ability to generate an easily-interpreted decision tree, acceptable accuracy rate, and efficiency in addressing discrete and numerical attributes. The study reports that the prediction accuracy when using automatic sampling was 82.19%, 93.15% when using linear sampling, 84.93% when using shuffled sampling, and 82.91% when using stratified sampling.

Another study that applies the C4.5 algorithm [12] utilized data from the Ministry of Health. The data state that Pekanbaru City suffered from bloodstock shortage by 32.4%, where the ideal bloodstock should be Pekanbaru should be 130.019 bags. This condition makes it difficult for several hospitals to fulfill the bloodstock availability. Limited bloodstock in Pekanbaru was accounted for by the limited number of donors and lack of public interest in donating their blood. This condition causes problems when demands on blood increase, whereas the stock is limited. In this study, the Decision Tree method was applied. C.45 algorithm was employed to analyze the data on voluntary blood donors. The analysis result of testing data found 50 records, generated six rules. The study concluded that self-employed individuals aged 19 years old are potential permanent donors.

In another study, C.45 algorithm was also employed to classify prospective insurance customers, developing rules required to classify customers' premium payment timeliness[13]. The rules were the result of the conversion of the classification tree. The C4.5 algorithm is considered significantly helpful for data classification since its results are often clear (decision tree or If-then rule), allowing users to easily explore the information about the data [14].

Considering the application of C.45 in previous studies, we employed C.45 algorithm to classify customer satisfaction levels to develop a decision tree that the cafe management can use to improve the customer satisfaction.

2. METHODS

2.1 Data Mining

Data mining describes the activity of information extraction and identification from various relevant databases using statistical, mathematical, artificial intelligence, and machine learning techniques [15].

2.2 The C4.5 Algorithm

C4.5 algorithm is [16] developed by Ross Qiunlan, used to generate a decision tree. The basic idea of this algorithm is to develop a decision tree by selecting attributes with the highest priority, or highest Gain score, or based on Entropy value[17]. This algorithm has two work principles, namely, making a decision tree and making rule models. The rules emerging from the decision tree will create an “if-then" condition[18].

2.3 Rapid Miner

Rapid Miner is a software developed by Dr Markus Hofmann from Institute of Technology Blanchardstown and Ralf Klinkenberg from rapid-i.com using GUI (Graphical User Interface) to allow users to use the software more easily[19]. This open-source software is developed using Java under GNU Public License and can be used in any operating system [20].

2.4 Research Framework

The following figure presents our research framework:

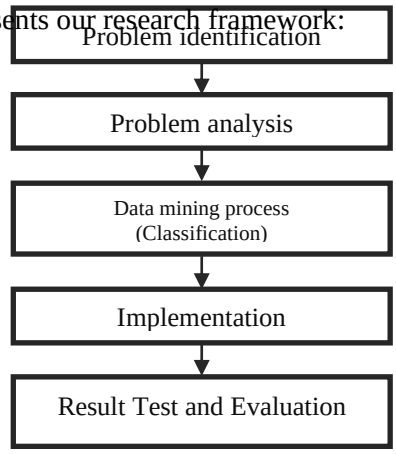

Figure 1 Research Framework

1. Problem identification
   In this stage, the identified problems were reviewed in order to find the purposes and problems statement of the study and to determine the customer satisfaction level.

2. Problem Analysis
   In this stage, the problem of the study was analyzed through several steps, namely identification, understanding, and analysis steps. In this stage, a new method was proposed to evaluate the facilitator performance by analyzing the data to determine the parameter or attributes required to calculate using the C.4.5. algorithm. The stage was performed in following steps:
   a) Input
      This refers to a data set obtained from literature and field studies. Data set refers to parameters or attributes required to determine the customer satisfaction level.
   b) *Data Mining*
      In this stage, the data set were processed into testing and training data using the C 4.5 algorithm.
   c) Output
      This refers to the data training result, which may generate the best pattern or rule to determine the customer satisfaction level.

3. Data Mining Process (Classification Process)
   The data mining process was applied as follow:

a) The training data were utilized to obtain attributes to determine the facilitator performance using the C4.5 algorithm.
b) Decision tree making using neural network-based decision tree.
c) The data were tested to estimate the accuracy of classification rules.
d) The data training result is compared to the data testing result.

4. Implementation
The implementation was carried ut to obtain the best pattern using the training and test data.

5. Testing and Evaluating the Result
The evaluation process was carried out by using Accuracy percentage and error percentage through manual calculation, which can be viewed from the data mining application.

3. RESULTS AND DISCUSSION

3.1. Data

The data used in this study were customer satisfaction data obtained from responses to a questionnaire distributed by Finn Cafe. Out of 200 collected responses, 30 responses were selected as a sample to be processed using the C4.5 Algorithm. The sample data were presented in the following Table 1.

Table 1 Data Sample

No.	Customer Name	Cafe Atmosphere	Cafe Location	Cafe Cleanliness	Service	Food Taste	Beverage Taste	Price	Satisfaction Level
1	Yoga	Comfortable	Quite spacious	Clean	Friendly	Delicious	Delicious	Quite affordable	Very Satisfied
2	Aulia	Quite comfortable	spacious	Clean	Friendly	Delicious	Quite delicious	Affordable	Very Satisfied
3	Andini	Comfortable	spacious	Clean	Friendly	Delicious	Delicious	Affordable	Very Satisfied
4	Andi	Quite comfortable	Quite spacious	Quite Clean	Quite Friendly	Delicious	Delicious	Quite affordable	Satisfied
5	Nanda	Quite comfortable	Quite spacious	Quite Clean	Quite Friendly	Quite delicious	Quite delicious	Quite affordable	Satisfied
6	Vika	Quite comfortable	Quite spacious	Clean	Less Friendly	Quite delicious	Quite delicious	Quite affordable	Quite Satisfied
7	Alex	Comfortable	Narrow	Clean	Friendly	Quite delicious	Delicious	Quite affordable	Quite Satisfied
8	Sinta	Less comfortable	Quite spacious	Quite Clean	Less Friendly	Quite delicious	Not delicious	Quite affordable	Quite Satisfied
9	Adinda	Comfortable	spacious	Quite Clean	Quite Friendly	Delicious	Quite delicious	Affordable	Satisfied
10	Zidni	Comfortable	Quite spacious	Quite Clean	Less Friendly	Quite delicious	Quite delicious	Quite affordable	Quite Satisfied
...	...	...	...	...	...	...	….	...	….
...	...	...	...	...	...	...	….	...	….
...	...	...	...	...	...	...	….	...	….
29	Verlita	Less comfortable	Quite spacious	Quite Clean	Less Friendly	Not delicious	Quite delicious	Quite affordable	Not Satisfied
30	Syakban zaman	Comfortable	Quite spacious	Clean	Friendly	Delicious	Delicious	Affordable	Very Satisfied

The attributes processed by the C4.5 algorithm are those with values, meaning that the customer name was excluded. The attributes to be processed are presented in the following Table 2.

Table 2 The C4.5 Algorithm attributes

Attribute	Value
Atmosphere	Comfortable, Quite Comfortable, Less Comfortable
Location	Spacious, Quite Spacious, Narrow
Cafe Cleanliness	Clean, Quite Clean, Dirty
Service	Friendly, Quite Friendly, not Friendly
Food Taste	Delicious, Quite Delicious, not Delicious
Beverage Taste	Delicious, Quite Delicious, not Delicious
Price	Affordable, Quite Affordable, expensive

The initial step of the C 45 Algorithm classification technique is processing and transforming data to make the raw data have complete attribute to generate a decision tree. The data to process were thirty data samples. Only seven attributes were processed through C4.5 Algorithm.

Table 3 Data Transformation

Cafe Atmosphere	**Cafe Location**	**Cafe Cleanliness**	**Service**	**Food Taste**	**Beverage Taste**	**Price**	**Satisfaction Level**
Comfortable	Quite spacious	Clean	Friendly	Delicious	Delicious	Quite affordable	Very Satisfied
Quite comfortable	spacious	Clean	Friendly	Delicious	Quite delicious	Affordable	Very Satisfied
Comfortable	spacious	Clean	Friendly	Delicious	Delicious	Affordable	Very Satisfied
Quite comfortable	Quite spacious	Quite Clean	Quite Friendly	Delicious	Delicious	Quite affordable	Satisfied
Quite comfortable	Quite spacious	Quite Clean	Quite Friendly	Quite delicious	Quite delicious	Quite affordable	Satisfied
Quite comfortable	Quite spacious	Clean	Less Friendly	Quite delicious	Quite delicious	Quite affordable	Quite Satisfied
Comfortable	Narrow	Clean	Friendly	Quite delicious	Delicious	Quite affordable	Quite Satisfied
Less comfortable	Quite spacious	Quite Clean	Less Friendly	Quite delicious	Not delicious	Quite affordable	Quite Satisfied
Comfortable	spacious	Quite Clean	Quite Friendly	Delicious	Quite delicious	Affordable	Satisfied
Comfortable	Quite spacious	Quite Clean	Less Friendly	Quite delicious	Quite delicious	Quite affordable	Quite Satisfied
...	...	...	...	...	….	...	….
...	...	...	...	...	….	...	….
...	...	...	...	...	….	...	….
Less comfortable	Quite spacious	Quite Clean	Less Friendly	Not delicious	Quite delicious	Quite affordable	Not Satisfied
Comfortable	Quite spacious	Clean	Friendly	Delicious	Delicious	Affordable	Very Satisfied

3.2. Equations

The data were classified properly in order to find out the total entropy and gain. The following equation was applied to determine the entropy value:

$$Entropy\ (S) = \sum_{i=1}^{n} -pi * \log_2 pi \quad (1)$$

Description:
S : Case Set
A : Attribute in S
n : Number of partition S
Pi : Proportion of Si to S

Meanwhile, the following equation was used to determine the gain value:

$$Gain\ (S, A) = Entropi(S) - \sum_{i=1}^{n} \frac{|Si|}{|S|} * Entropy \quad (2)$$

Description:
A : Attribute in S
n : Number of partition A
|Si| : The number of case in the-ith partition
|S| : Number of cases

The total entropy for customer satisfaction was as follow.

$$Total\ Entropy = \left(-\left(\frac{number\ of\ very\ satisfied}{Number\ of\ cases} * \log_2 \frac{Number\ of\ very\ satisfied}{Number\ of\ cases}\right)\right. + \left(-\left(\frac{Jnumber\ of\ satisfied}{Number\ of\ cases} * \log_2 \frac{number\ of\ satisfied}{Number\ of\ cases}\right)\right) + \left(-\left(\frac{Number\ of\ quite\ satisfied}{Number\ of\ cases} * \log_2 \frac{number\ of\ quite\ satisfied}{Number\ of\ cases}\right)\right) + \left.\left(-\left(\frac{Number\ of\ unsatisfied}{Number\ of\ cases} * \log_2 \frac{Number\ of\ unsatisfied}{Number\ of\ cases}\right)\right)\right)$$

$$Total\ Entropy = \left(-\left(\frac{5}{30} * \log_2 \frac{5}{30}\right) + \left(-\left(\frac{12}{30} * \log_2 \frac{12}{30}\right)\right) + \left(-\left(\frac{9}{30} * \log_2 \frac{9}{30}\right)\right) + \left(-\left(\frac{4}{30} * \log_2 \frac{4}{30}\right)\right)\right)$$

$$= 0{,}430827083 + 0{,}528771 + 0{,}521089678 + 0{,}38758541$$

$$= 1{,}868273$$

Calculate the number of cases, and calculate the entropy for each attribute value and the gain value of each attribute.

3.3 Finding Entropy of all attributes

The entropy of all attributes in was calculated to obtain the starting node to be the root of decision tree. Entropy of each attribute was calculated after obtaining the total entropy. The result was presented in the following table:

Table 4 Entropy and Gain Calculation

Attribute	**Number of Attribute**	**Number of Cases**	**Very Satisfied**	**Satis-fied**	**Quite Satisfied**	**Not Satisfied**	**Entropy**	**Gain**
		30	5	12	9	4	1.868273	
Atmos-phere	Comfort-able	13	4	6	3	0	1.526235	-2.08357 0457
	Quite comfort-able	13	1	6	5	1	1.614331	
	Less comfort-able	4	0	0	1	3	0.811278	
Location	spacious	13	4	7	2	0	1.419556	-2.3332 1995
	Quite spacious	15	1	5	6	3	1.781937	
	Narrow	2	0	0	1	1	1	
Cafe Clean-liness	Clean	11	5	4	2	0	1.494919	-1.1560 73767
	Quite Clean	19	0	8	7	4	1.529428	
	Dirty	0	0	0	0	0	0	
Service	Friendly	11	5	7	1	0	1.246499	-1.4390 0826
	Quite Friendly	10	0	5	1	2	1.296578	
	Less Friendly	9	0	0	7	2	0.764205	
Food Taste	Delicious	11	5	6	0	0	0.99403	-0.5050 37286
	Quite delicious	17	0	6	9	2	1.37928	
	Not delicious	2	0	0	0	2	0	
Beverage Taste	Delicious	11	4	6	1	0	1.322179	-2.0496 23051
	Quite delicious	16	1	6	7	2	1.677421	
	Not delicious	3	0	0	1	2	0.918296	
Price	Afford-able	11	3	8	0	0	0.845351	-0.8136 69192
	Quite afford-able	18	2	4	8	4	1.836592	
	Expensive	1	0	0	1	0	0	

3.4 Determining Root Node

As shown in the table above, the highest gain value was found in "Food Taste" average (i.e., 0.5037286.) Hence, the "food taste" attribute was set as the root of decision tree to determine the customer satisfaction in Finn Cafe. The following figure illustrates the decision tree.

Figure 2 Decision Tree

3.5 Testing

Classification Test in this study were carried out using validation test with confusion matrix. The result showed an accuracy of 71.43%, as presented in the following figure .

accuracy: 71.43%

	true Sangat Puas	true Puas	true Cukup Puas	true Tidak Puas	class precision
pred. Sangat Puas	1	0	0	0	100.00%
pred. Puas	0	3	1	0	75.00%
pred. Cukup Puas	0	0	1	1	50.00%
pred. Tidak Puas	0	0	0	0	0.00%
class recall	100.00%	100.00%	50.00%	0.00%	

Figure 3 Confusion matrix model

4. CONCLUSIONS

Based on the data processing, it is concluded that the root of the decision tree is the food taste. The validation test using confusion matrix exhibited an accuracy level of 71.43%.

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