Algorithm Decission Tree C4.5 and Backpropagation Neural Network for Smarthpone Price Classification

[1]Muhammad Ridho Al Fathan, [2]M. Fadhil Arfa,
[3]Habibah Br. Lumbantobing, [3]Rahmaddeni
[1,2,3,4]Departement of Informatic Engineering, STMIK Amik Riau, Jalan Purwodadi, Pekanbaru, Riau
Email: [1]2110031802149@sar.ac.id, [2]2110031802147@sar.ac.id,
[3]2110031802152@sar.ac.id, [4]rahmaddeni@sar.ac.id

Article Info

Article history:
Received Sep 7th, 2022
Revised Oct 20th, 2022
Accepted Nov 12th, 2022

Keyword:
Backpropagation
C4.5
Classification
Price
Smartphone

ABSTRACT

Nowadayst, everyone had at least one smartphone, this is because of its role that can help people daily activities easier. The need for decision of smartpone price was important what best smartpone to buy. Decision Tree C4.5 and Backpropagation Neural Network (BPNN) are both machine learning algorithms that can be used for smartphone price classification. There were data smartphone prices from major companies from Kaggle. The data was divided into 2000 training data and 1000 test data, the price range of smartphones based on the features provided. The analysis needed was the relationship between the features of smartphone and the selling price. To get this information, data mining techniques could be used. This study used the Decission Tree C4.5 algorithms and the Backpropagaition Neural Network algorithm for classification problems. In this study, the technique used would be compared to a better algorithm in carrying out the classification process. The classification method consisted of predictor variables and one target variable. The software used to process the data was Rapid Miner software. The results of the study got the accuracy of the Back-propagation Neural Network algorithmwas 96.65% and the same data was also applied to the C4.5 algorithms with an accuracy of 83.75%. From the research results, it can be concluded that the back-propagation neural network algorithm is the best algorithm for smartphone price classification with accuracy 96.65%.

Copyright © 2022 Puzzle Research Data Technology

Corresponding Author:
Rahmaddeni,
Departement of Informatic Engineering,
STMIK AMIK Riau,
Jalan Purwodadi, Pekanbaru, Riau
Email: rahmaddeni@sar.ac.id

DOI: http://dx.doi.org/10.24014/ijaidm.v5i2.19064

1. INTRODUCTION

In this technological age, smartphones are a requirement. In fact, everyone owns at least one smartphone due to its ability to make daily tasks easier [1]. Smartphones come with a wide range of features, including cameras, RAM, processors, touch screens, 4G capabilities, and other cutting-edge technologies [2]. The cost of different types of smartphones on the market are measured against this feature. Price plays a significant role in business and prompts clients to ask, "Is the price in accordance with the requirements obtained?"[3].

Decision Tree C4.5 and Backpropagation Neural Network (BPNN) are both machine learning algorithms that can be used for smartphone price classification. BPNN, on the other hand, is a type of artificial neural network that is commonly used for supervised learning tasks such as classification. It uses a back-propagation algorithm to adjust the weights of the network in order to minimize the error between the predicted and actual output. BPNN can learn complex and non-linear relationships between inputs and outputs, making it suitable for handling high-dimensional data. Both algorithms have their own advantages and disadvantages, and the choice of which one to use depends on the specific problem and the available data. Decision Tree C4.5 is a decision tree algorithm that uses information gain to determine the feature that best splits the data into different classes. It is known for its ability to handle both continuous and categorical data, and it's easy to understand the decision making process.

Kaggle provides information about smartphone costs from key companies. The data separates the pricing range according to the specified features. For improved utilization, data mining can be applied to obtain more new information. Data mining is utilized to process massive data sets [4]. In accordance with the objectives of the data mining application, a search for patterns or trends is conducted on the data. The outcomes of data mining processing can be used to make necessary judgments or conduct necessary analysis [5].

The necessary analysis is the relationship between the smartphone's characteristics and its selling price. Data mining techniques can be used to acquire this information. Classification is an established methodology. Classification is the process of evaluating data objects in order to assign them to one of the available classes. Classification creates a model from existing training data, then applies that model to categorize fresh data [6].

Classification techniques have been utilized extensively for a variety of goals in numerous disciplines. Earlier research [7], [8], dan [9] Using the decision tree technique, C4.5 achieved an average precision of 90%. Based on the accuracy, it can be stated that the C4.5 algorithm performs exceptionally well when classifying situations. The C4.5 algorithms is commonly used to classify data with numeric and categorical characteristics. The categorization findings can be used to forecast the value of the new record's discrete type attribute. Smartphone price classification is the task of determining the price range of a smartphone based on its features and specifications. This can be done using various machine learning algorithms, such as Decision Tree C4.5 and Backpropagation Neural Network (BPNN), as well as other algorithms like Random Forest, Support Vector Machines (SVMs), and k-Nearest Neighbors (k-NN).

The features used for smartphone price classification may include the brand, model, processor, camera, storage, RAM, battery capacity, and other specifications. The data can be collected from various sources such as online retailers, smartphone databases, and user reviews. The performance of the algorithm can be evaluated using metrics such as accuracy, precision, recall, and F1-score. Cross-validation can be used to avoid overfitting and ensure that the model generalizes well to new data. It's important to note that the performance of the algorithm will depend on the quality and quantity of the data, and the features selected, so feature engineering and data preprocessing are important steps in the process. [10].

The backpropagation algorithm is another frequently employed classification technique. Backpropagation is a supervised learning algorithm and multi-layer by adjusting the weights in each layer, with the initial step determining the number of input, hidden, and output layers [11]. Research [12] in the case of the classification of rambutan fruit species with an accuracy of 90%, other studies [13], [14] and [15] an average precision over 90%. Change the learning rate and maximum epoch values during implementation to achieve the best classification results.

Based on prior research demonstrating that the C4.5 and *backpropagation* algorithms may be used to classify with a reasonable degree of precision, this study apply both methods to the categorization of smartphone costs. It would be determined from both algorithms which classification algorithm is superior in the given scenario. The data utilized is obtained from Kaggle. With the expectation that the results of this study would be able to classify the prices of new input for smartphones in the future.

The objective of this research is to identify a categorization system for smartphone prices that can achieve a high level of precision. The research conducted to suit the needs of data providers is intended to reveal the relationship between the company's offered features and the price. For future study on classifying smartphone prices or making other predictions, it is anticipated that methods with high precision will be applied.

2. RESEARCH METHOD

The research technique consists of the processes that are carried out in a planned, systematic manner in order to provide a solution to an issue. Figure 1 illustrates the methods that would be implemented in this study. Using a mobile price classification dataset from Kaggle is a great way to get started with a smartphone price classification project. Kaggle is a platform that hosts a variety of datasets, including many that are related to machine learning and classification tasks. When using a mobile price classification dataset from Kaggle, it's important to make sure that the dataset is relevant to the task, and that it contains enough data to train and evaluate the model. The dataset includes information on the features of the smartphones, such as brand, model, specifications, and price. To preprocess the data to get it into a format that can be used by your machine learning algorithm. This may involve cleaning the data, handling missing values, and encoding categorical variables.

After preprocessing the data, Machine learning algorithm, such as Decision Tree C4.5 or Back-propagation Neural Network (BPNN), to train a model on the dataset. You can then use the trained model to classify new smartphones based on their features and specifications. It's important to evaluate the performance of the model using appropriate evaluation metrics, and fine-tune the model by adjusting the hyper-parameters, or trying different algorithms, if necessary.

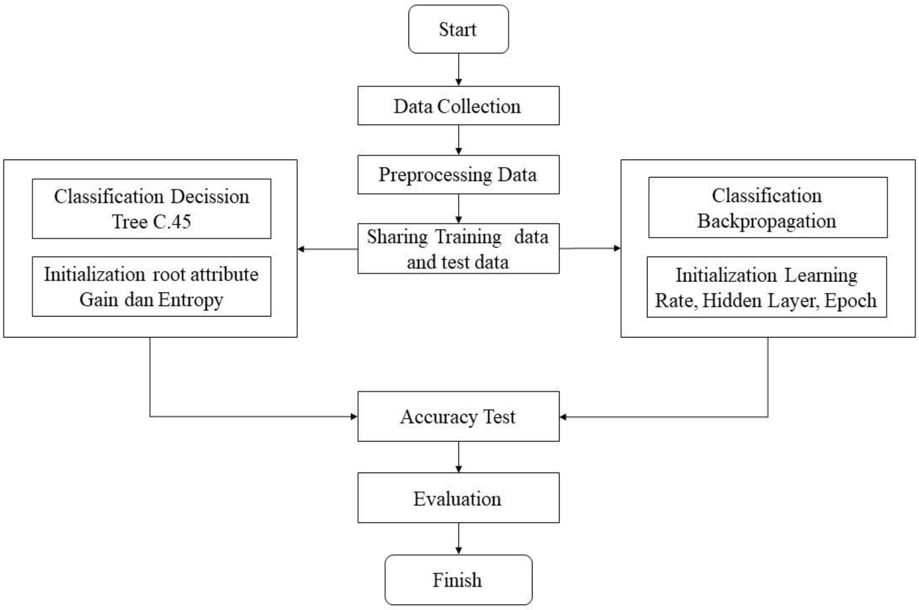

Figure 1. Research Methodology

This study utilizes the Mobile Price Classification data from Kaggle as its dataset. The data is divided into two parts: the train data, which consists of 2,000 records, and the test data, which consists of 1,000 records with the qualities listed in Table 1.

Table 1. Attributes of the Dataset

No	Attribute	Information
1	battery_power	Battery capacity in mAh
2	blue	Have bluetooth or not
3	clock_speed	Processor speed
4	dual_sim	Have dual sim or not
5	fc	Front camera
6	four_g	Have 4G or not
7	int_memory	Internal memory in GB
8	m_dep	Smartphone thickness in CM
9	mobile_wt	Weight of smartphone
10	pc	Main camera
11	n_cores	Number of cores in processor
12	px_height	Long pixel resolution
13	px_width	Wide pixel resolution
14	ram	Amount of ram in MB
15	sc_h	Screen length
16	sc_w	Screen width
17	talk_time	How long can the smartphone be used for talk in one charge
18	three_g	Have 3G or not
19	touch_screen	Using touch screen or not
20	wifi	Have wifi or not
21	price_range	Target of variable

There are four targets in the data, and they are defined by the characteristics offered by smartphone manufacturers, including RAM, camera quality, the existence or absence of 4G, and the sharing of other features. These objectives are shown in Table 2.

Table 2. Target of variable

No	Target	Information
1	0	Low cost
2	1	Medium cost
3	2	High cost
4	3	Very high cost

The study technique includes various steps, including the collection of data that will be utilized for implementation, the analysis of the parameters used to process the data by normalizing the data, and the data preparation stage. The preprocessing stage is defined as the initial step to eliminate meaningless or superfluous data [16] . The ratio of data distribution between training data and testing data is 80:20. Then, create a model of both the C4.5 and Backpropagation algorithms. Perform the data training procedure with the selected algorithm thereafter. At this point, the model will analyze the obtained features and modify parameter values throughout the exercise. The subsequent step is to examine the model with test data, after which the findings will be categorized and compared with the actual test data parameter values to determine the level of accuracy in predicting the test data process and the actual test data.

2.1. C4.5 Agorithm

The C4.5 method is a widely used decision tree or decision tree algorithm due to its advantages over other algorithms. One of its benefits is that it is simple to comprehend, has an appropriate level of precision, is effective at managing discrete-type attributes, and can handle numeric attributes [17].

At the data-learning stage, the C4.5 algorithm builds a decision tree from training data, which are cases or database entries (tuples). The three operating concepts of the C4.5 algorithm's data-learning stage are as follows:

a. Decision Tree Making
b. Decision tree pruning and evaluation (optional)
c. Generating rules from a decision tree (optional)

The formula for the C4.5 algorithm is:

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

Information:

S : Case Collection
A : Attribute
N : Number of attribute partitions A
|Si| : Number of cases on partition i
|S| : Number of cases in S

While the Entropy value can be calculated using the following equation:

$$Entropy(A) = \sum_{i=1}^{n} -pi * Log_2 pi \quad (2)$$

Information:

S : Case Collection
A : Feature
n : Number of partitions S
pi : Proportion of Si to S

2.2. Backpropagation Neural Network Algorithm

The backpropagation network model is the most commonly used supervised learning or training method. The backpropagation algorithm consists of multiple layers, including the input layer, the hidden layer, and the output, with the weights of each layer's connections being altered [18]. The output will be propagated backwards in the hidden layer and then from the hidden layer to the input layer if it is not as intended [19].

Three steps comprise the backpropagation network training algorithm [20]. The next three stages will be repeated until the halting condition is met:

1. Feed forward stage (feedforward).
2. Feedback stage (backpropagation).
3. The stage of updating the weights and biases.

The loop will terminate if *epoch ≥ Max Epoch* or *α ≥ max α*.
In detail the backpropagation network training algorithm can be described as follows:

Step 0 : Initialization of weights, training rate constant (α), error tolerance or weight value (when utilizing the weight value as a stop condition), as well as the maximum number of epochs (if using the number of epochs as a stop condition).
Step 1 : As long as the stop condition has not been met, perform actions 2 through 9.
Step 2 : Follow steps 3 through 8 for every pair of training patterns.
Step 3 : Stage I: Feed forwand}. Each input unit receives a signal and transmits it to the unit directly above it.
Step 4 : Each unit in the hidden layer (from the first unit to the pth unit) has its weight multiplied by p and its bias totaled and added.
Step 5 : Every output unit (yk, k=1,2,3,...m) is multiplied by the weight and added to the bias.
Step 6 : {Phase II: Backward propagation}. During training, each output unit (yk,k=1,2,3,...m) receives the target pattern tk based on the input/input pattern; the output layer error information (δk) is then determined. (δk) is sent to the layer underneath it and utilized to determine the weight and bias correction (ΔWjk dan ΔWok) between the hidden layer and the output layer.
Step 7 : For each unit in the hidden layer (from the 1st to the p-th unit; i=1…n;k=1…m) the hidden layer error information (δj) is calculated. j is then used to calculate the weight and bias correction (ΔVji and Vjo) between the input layer and the hidden layer.
Step 8 : {Phase III: Updating weights and bias}. Each output unit (yk, k=1,2,3,…,m) is updated with its bias and weight (j=0,1,2,...p) so as to produce new weights and biases. In the same manner, the weight and bias are updated for each hidden unit from the first unit to the pth unit.
Step 9 : Test the stop condition (end of iteration).

3. RESULTS AND ANALYSIS

In this section, we will examine the outcomes of utilizing the decision tree C4.5 algorithm and Backpropagation Neural Network to classify smartphone prices. The test utilizes 2000 data with 21 attributes extracted from the supplied dataset. Each data is compared to every existing data.

3.1. C4.5 Algorithm

The stages in the C4.5 algorithm are as follows:

1. Process data input on tools

In order to import the data into the quick miner, a few attributes are modified to identify the data'slabel. The price range column serves as an identifier and transforms the data into polynomials. Because the C4.5 decision tree cannot read numeric labels, the change to polynomial was made. Figure 2 displays the effects of data modifications.

Table 3. Preprocessing result dataset

Row No.	Price Range	Battery Power	Blue	Clock Speed	Dual Sim	FC	Four-g	Int Memory	M_Dep
1	1	842	0	2.200	0	1	0	7	0.600
2	2	1021	1	0.500	1	0	1	53	0.700
3	2	583	1	0.500	1	2	1	41	0.900
4	2	615	1	2.500	0	0	0	10	0.800
5	1	1821	1	1.200	0	13	1	44	0.600
6	1	1859	0	0.500	1	3	0	22	0.700
7	3	1821	0	1.700	0	4	1	10	0.800
8	0	1954	0	0.500	1	0	0	24	0.800
9	0	1445	1	0.500	0	0	0	53	0.700
10	0	509	1	0.600	1	2	1	9	0.100
11	3	769	1	2.900	1	0	0	9	0.100
1999	1	1815	0	2.800	0	2	0	33	0.600
2000	2	803	1	2.180	0	7	0	17	1

2. Modeling process

At this point, modeling will be performed using the fast miner tools depicted in Figure 3.

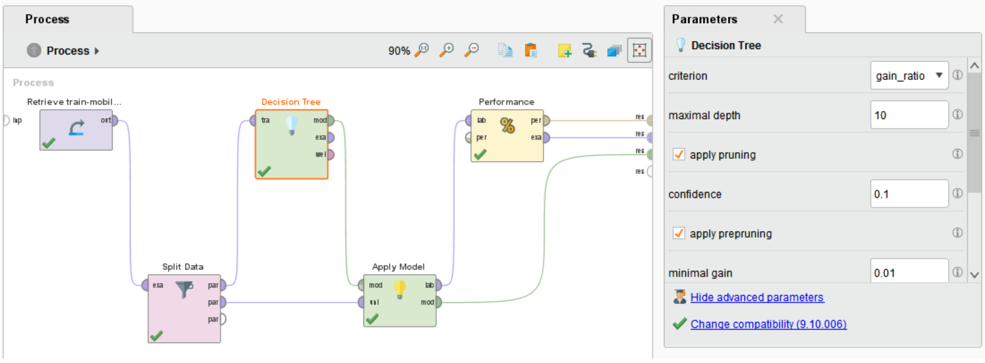

Figure 2. Decision Tree Model

In the image above, it can be seen that the initial inputted data has been entered into the process. Then, divide the training data and test data using an 80:20 ratio. Select linear sampling as the mechanism for data exchange. Utilize the Decission Tree technique with the parameter values shown in Figure 3. Utilize the Apply Model and Performance option to demonstrate the distorted decision tree method's precision.

3. Test Results

The outcomes of training and testing data on 2000 smartphone price data are depicted in Figure 4 below as the Performance Vector.

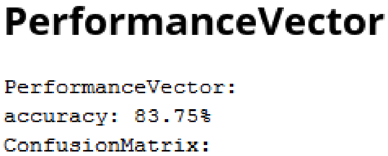

Figure 3. Performance vector

The test results utilizing the C4.5 algorithm indicate a performance accuracy of 83.75 %. Figure 5 depicts the outcomes of the resulting decision tree.

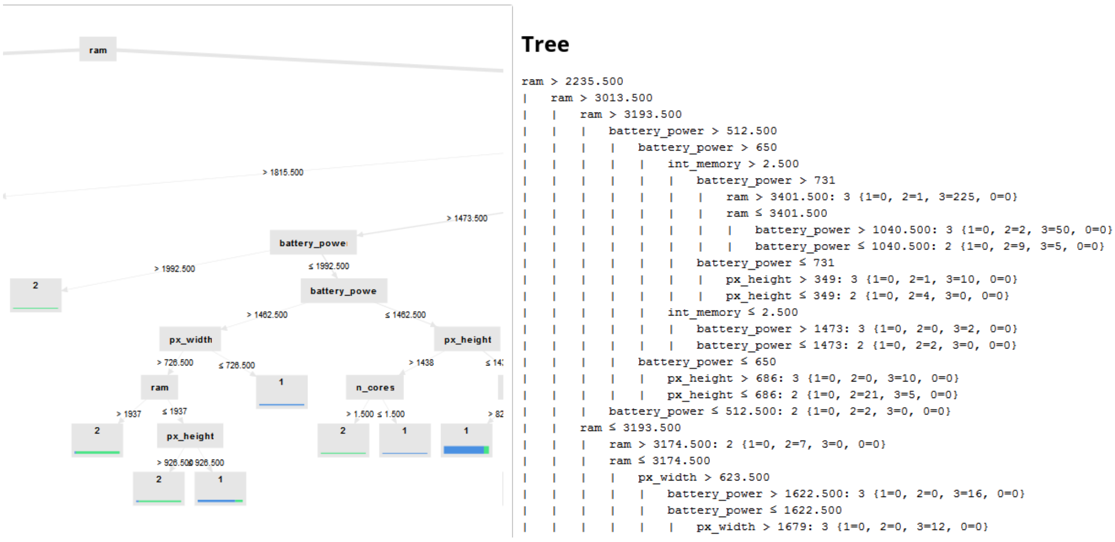

Figure 4. Decision tree

4. Confusion Matrix Results

The confusion matrix dataset processing results using the C4.5 algorithm with accuracy 83.75% are depicted in the table shown table 4.

Table 4. Confussion Matriks

	True 1	True 2	True 3	True 0	Class precision
Pred.1	83	15	0	10	76.85%
Pred.2	10	70	11	0	76.92%
Pred.3	0	10	88	0	89.80%
Pred.0	9	0	0	94	91.26%
Class recall	81.37%	73.68%	88.89%	90.38%	

3.2. Backpropagation Neural Network Algorithm

Following are the steps of the Backpropagation Neural Network algorithm:

1. Process inputted data on tools

Importing the data into the fast miner involves modifying some attributes to determine the data's label. The price range column is used as a label and polynomializes the data. The reason for the switch to polynomial is because the C4.5 decision tree cannot read numeric labels. Table 5 depicts the outcomes of data alterations.

Table 5. Preprocessing Result Dataset

Row No.	Price Range	Battery Power	Blue	Clock Speed	Dual Sim	FC	Four-g	Int Memory	M_Dep
1	1	842	0	2.200	0	1	0	7	0.600
2	2	1021	1	0.500	1	0	1	53	0.700
3	2	563	1	0.500	1	2	1	41	0.900
4	2	615	1	2.500	0	0	0	10	0.800
5	1	1821	1	1.200	0	13	1	44	0.600
6	1	1859	0	0.500	1	3	0	22	0.700
7	3	1821	0	1.700	0	4	1	10	0.800
8	0	1954	0	0.500	1	0	0	24	0.800
9	0	1445	1	0.500	0	0	0	53	0.700
10	0	509	1	0.600	1	2	1	9	0.100
11	3	769	1	2.900	1	0	0	9	0.100
1999	1	1815	0	2.800	0	2	0	33	0.600
2000	2	803	1	2.180	0	7	0	17	1

2. Modeling process

At this point, fast miner modeling tools will be utilized. As shown in Figure 8, this procedure employs cross validation to test the model once it has been inputted. The data that has been read are then input into the cross validation operator; in this study, 10 fold validation is utilized for cross validation.

3. Training Process

The subsequent process that is carried out is the training process, which is carried out in a cross validation operator using a neural network algorithm. Using this algorithm, the data is divided into two parts, the first of which is used for datatraining and the second for datatesting., as depicted in Figure 5.

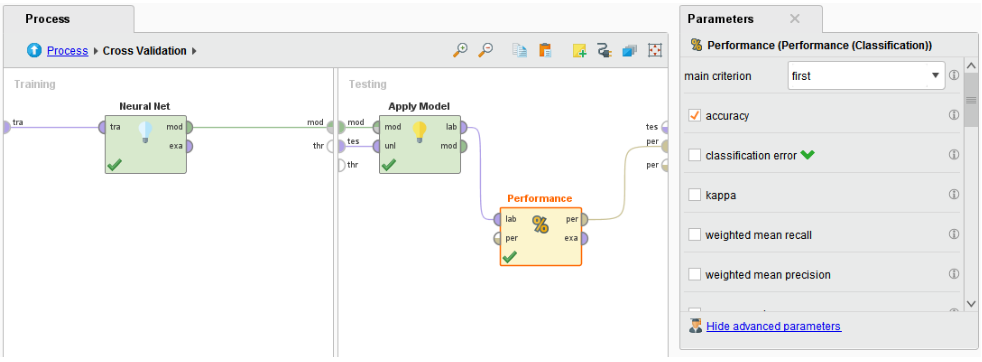

Figure 5. Backpropagation Training Process

The training procedure depicted in the image above is carried out using a neural network operator. The training employs a 12 – 15 – 8 – 1 structure with 500 training cycles, 0.01 learning rate, and 0.1 momentum validation.

4. Testing Process

The final step of this procedure, following training, is testing the dataset using the backpropagation function performed on the previous training data. This testing is performed by inserting apply models and performance with accuracy as the key criterion, as depicted in Figure 6.

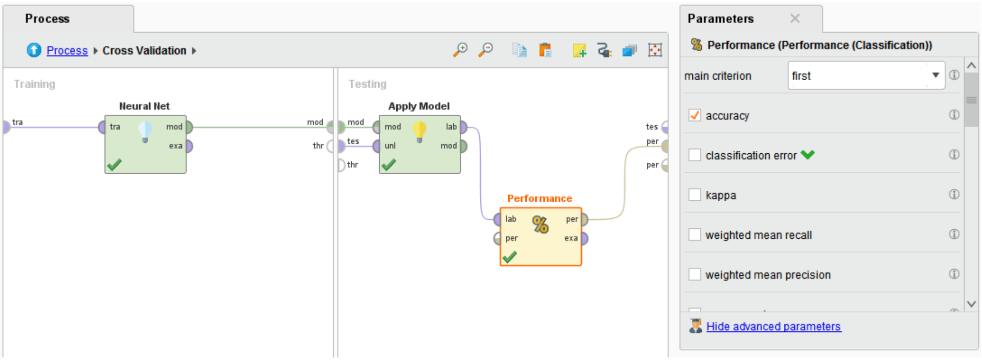

Figure 6. Backpropagation Testing Model

5. Test Results

As depicted in Figure 7, the Performance Vector displays the outcomes of the training and testing of 2000 data.

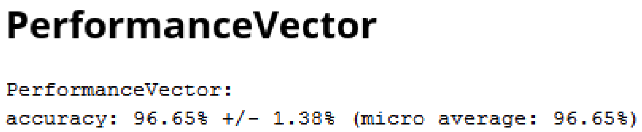

Figure 7. Performance Vector

The test results utilizing the neural network technique indicate a performance accuracy of 96.65%.

6. Confusion Matrix Results

Table 6 depicts the confusion matrix table resulting from the processing of the dataset with the Backportation algorithm on the neural network with Accuracy 83.75%.

Table 6. Confusion matrix

	True 1	True 2	True 3	True 0	Class precision
Pred.1	83	15	0	10	76.85%
Pred.2	10	70	11	0	76.92%
Pred.3	0	10	88	0	89.80%
Pred.0	9	0	0	94	91.26%
Class recall	81.37%	73.68%	88.89%	90.38%	

4. CONCLUSION

On the basis of research conducted using rapid miner tools on Mobile Price Classification data consisting of 2,000 data records obtained from a machine learning repository located at http://www.kaggle.com, it can be concluded that the C4.5 and Backpropagation algorithms can be utilized effectively for classification in data mining. The accuracy of smartphone price classification is determined by the performance of each model. In conclusion, the result algorithm of comparison performances values between Decision Tree C4.5 is 83,75% and Back-propagation Neutral Network is 96,65%. It means back-propagation as higher value performances than Decision Tree C4.5. The comparison results demonstrate that the Back-propagation Neural Network algorithm employs a 12 – 15 – 8 – 1 structure, 500 training cycles, 0.01 learning rate, and 0.1 momentum resulted in an accuracy value of 96.65%, demonstrating that the classification is significantly more accurate than the C4.5 algorithm. The number of cases and their features in a classification can influence the structure of the decision tree in the C4.5 algorithm. With these conclusions, fresh data can be gathered to satisfy the need to determine the relationship between smartphone features and pricing.

REFERENCES

[1] P. S. A. Dewi and N. W. S. Suprapti, "MEMBANGUN LOYALITAS PELANGGAN MELALUI KEPUASAN YANG DIPENGARUHI OLEH KUALITAS PRODUK, PERSEPSI HARGA DAN CITRA MEREK (Studi Pada Produk Smartphone Merek Oppo)," *Matrik J. Manajemen, Strateg. Bisnis dan Kewirausahaan*, p. 87, 2018.

[2] O. B. Kumala, "Pengaruh Word Of Mouth Terhadap Minat Beli Konsumen Pada Tune Hotels Kuta-Bali," *Jakarta Univ. Indones.*, pp. 3642–3658, 2012.

[3] M. Asim, "Mobile Price Class prediction using Machine Learning Techniques Mobile Price Class prediction using Machine Learning Techniques," no. March, 2018.

[4] E. S. R. Br.Situmorang, M. K. Anam, R. Rahmaddeni, and A. N. Ulfah, "Perbandingan Algoritma Svm Dan Nbc Dalam Analisa Sentimen Pilkada Pada Twitter," *CSRID (Computer Sci. Res. Its Dev. Journal)*, vol. 13, no. 3, p. 169, 2021.

[5] S. Widaningsih, "Perbandingan Metode Data Mining Untuk Prediksi Nilai Dan Waktu Kelulusan Mahasiswa Prodi Teknik Informatika Dengan Algoritma C4,5, Naïve Bayes, Knn Dan Svm," *J. Tekno Insentif*, vol. 13, no. 1, pp. 16–25, 2019.

[6] D. P. Utomo, "Analisis Komparasi Metode Klasifikasi Data Mining dan Reduksi Atribut Pada Data Set Penyakit Jantung," vol. 4, no. April, pp. 437–444, 2020.

[7] I. Anggraeni and S. Andriani, "Implementasi algoritma c.45 untuk klasifikasi deteksi serangan pada protokol jaringan," vol. 18, no. 2, pp. 62–68, 2021.

[8] M. R. Matondang, M. R. Lubis, and H. Satria, "Analisis Data mining dengan Metode C . 45 pada Klasifikasi Kenaikan Rata-Rata Volume Perikanan Tangkap," vol. 2, no. 2, pp. 74–81, 2021.

[9] R. A. Syahfitri, A. P. Windarto, and H. Okprana, "Klasifikasi Calon Nasabah Baru Menggunakan C . 45 Sebagai Dasar Pemberian Pertanggungan Asuransi di PT Asuransi Central Asia Pematangsiantar," vol. 1, no. 1, 2021.

[10] A. Zulkifli, "Metode C45 Untuk Mengklarifikasi Pelanggan Perusahaan Telekomunikasi Seluler Akhmad," vol. 2, no. 1, pp. 65–76, 2016.

[11] F. Izhari, M. Zarlis, and Sutarman, "Analysis of backpropagation neural neural network algorithm on student ability based cognitive aspects," 2020.

[12] F. Rizal *et al.*, "Penerapan algoritma backpropagation untuk klasifikasi jenis buah rambutan berdasarkan fitur tekstur daun," vol. 1, no. 2, pp. 2–9, 2020.

[13] F. A. Hizham *et al.*, "Implementasi Metode Backpropagation Neural Network (BNN) dalam Sistem Klasifikasi Ketepatan Waktu Kelulusan Mahasiswa (Studi Kasus : Program Studi Sistem Informasi Universitas Jember) (Implementation of Backpropagation Neural Network (BNN) Method i," 2018.

[14] P. D. Putra and D. P. Rini, "Peningkatan Akurasi Klasifikasi Backpropagation Menggunakan Artificial Bee Colony dan K-NN Pada Penyakit Jantung," vol. 5, pp. 208–215, 2021.

[15] S. H. Hasanah and S. M. Permatasari, "Metode Klasifikasi Jaringan Syaraf Tiruan Backpropagation Pada Mahasiswa Statistika Universitas Terbuka," vol. 14, no. 2, pp. 243–252, 2020.

[16] Rahmaddeni, M. K. Anam, Y. Irawan, S. Susanti, and M. Jamaris, "Comparison of Support Vector Machine and XGBSVM in Analyzing Public Opinion on Covid-19 Vaccination," *Ilk. J. Ilm.*, vol. 14 No. 1, 2022.

[17] D. H. Kamagi and S. Hansun, "Implementasi Data Mining dengan Algoritma C4 . 5 untuk Memprediksi Tingkat Kelulusan Mahasiswa," vol. VI, no. 1, pp. 15–20, 2014.

[18] M. Agustin, "Penggunaan Jaringan Syaraf Tiruan Backpropagation untuk Seleksi Penerimaan Mahasiswa Baru Pada Jurusan Teknik Komputer Di Politeknik Negeri Sriwijaya," 2012.

[19] F. Ortega Zamorano, J. M. Jarez, G. E. Juarez, and L. Franco, "FPGA Implementatation of Neurocomputational Models: Camparison Between Standard Backpropagation and C-Mantec Constructive Algorithm," 2017.

[20] Y. A. Lesnussa, L. J. Sinay, and M. R. Idah, "Aplikasi Jaringan Saraf Tiruan Backpropagation untuk Penyebaran Penyakit Demam Berdarah Dengue (DBD) di Kota Ambon," *J. Mat. Integr.*, vol. 13, no. 2, p. 63, 2017.

BIBLIOGRAPHY OF AUTHORS

Muhammad Ridho Al Fathan, student at the STMIK Amik Riau School of Informatics & Computer Management, departement of informatics engineering for the 2022 academic year who is interested in data science. The focus of researcher is data mining

M Fadil Arfa, student at the STMIK Amik Riau School of Informatics & Computer Management, departement of informatics engineering for the 2022 academic year who is interested in data science. The focus of researcher is artificial intelligence.

Habibah Br Lumbantobing, student at the STMIK Amik Riau School of Informatics & Computer Management, departement of informatics engineering for the 2022 academic year who is interested in data science. this is my first journal on data science hope to be able to make more journals in the future.

Rahmaddeni was born in Padang and currently a Lecturer from Department of Informatics at STMIK Amik Riau. He actively teaches in the fields of Machine Learning and Data Mining. Received Bachelor's Degree in Informatic Engineering Department in STMIK Amik Riau and Master's Degree in Informatic Engineering in Universitas Putra Indonesia "YPTK" Padang. The focus of he research is Machine Learning and Data Mining.