



# Implementation of c 5.0 algorithm for predicting agricultural materials sales stock

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## ABSTRACT

Cv. Mitra Karya Sejati was founded in 1998 by Tardi Sutanto as a trading company in the field of agricultural materials, such as multipurpose fertilizers, pesticides and seeds. CV. Mitra Karya Sejati is often in short supply due to the increasing demand for consumer goods and even some items are not sold, so it is difficult to predict the stock of goods in the warehouse so far based on sales data which is used only as data to report monthly sales results which will then not be used again. Companies need a sales forecasting system to help you plan stock items in the future. The application of C 5.0 to data mining can make it easier for companies to estimate stock of goods based on sales of agricultural materials. The Data Mining application is built using the PHP programming language and MySQL database to reduce inventory planning losses. Through the proposed system can help companies estimate the stock of goods to be provided to minimize losses. The results of this study obtained sales test data identified as bestsellers on a total attribute of 193 on Cu Daun and Dolimite products, identified as unsold by 0, on CU Daun and Dolimit products, so that it has an accuracy value of 100%, this result becomes the company's benchmark in determining inventory and stock sales in the next month.

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## 1. INTRODUCTION

The rapid development of technology at present enables people to easily access various types of information. Almost the entire Indonesian population, including children, teenagers, and adults, is involved with technology on a daily basis (Umam & Christanto, 2023). The role of technology today is considered capable of replacing human activities. With the fast-paced technological advancements, there is an increasing need for effective and efficient information presentation. The presentation of information should have transitioned from the old manual recording system to a computerized system (Mankar, 2023).

CV. Mitra Karya Sejati, located at Jl. Menggala Sakti Km.24, Kec. Tanah Putih, Kab. Rokan Hilir, Riau, is a trading company that offers affordable agricultural tools and materials. To support its sales services, CV. Mitra Karya Sejati utilizes a sales information system. Maintaining a stable inventory of agricultural products at low prices presents a challenge in itself. However, inventory management is a task that should not be taken lightly. Excessive inventory increases the risk of goods being damaged, while insufficient inventory raises the likelihood of product shortages, which can lead to delayed profits and disappointed customers. In recent months, sales of agricultural materials have witnessed an increase, resulting in frequent shortages of goods in the warehouse due to the growing consumer demand and unsold items. For instance, in the period from June to September 2021, there was a shortage of Meroke fertilizer and damage to CU Daun fertilizer, resulting in financial losses. The high volume of orders for specific fertilizers during that period made it difficult to predict the stock of goods in the warehouse. Consequently, having accurate stock information is crucial in determining the number of products to be shipped in the following month (Nursobah et al., 2022). Companies often face challenges in accurately predicting future commodity stocks based on previous sales data. Such predictions significantly impact the decision-making process regarding which products will be successful in the market and which ones won't. The present study is based on sales data from CV. Mitra Karya Sejati. The company solely uses monthly sales data for reporting purposes, without utilizing it further.

Data mining is a valuable tool for extracting information from large datasets to facilitate prediction, classification, and estimation. The C 5.0 algorithm, a data mining algorithm, is specifically applicable to Decision Tree techniques and represents an improvement over the ID3 and C 4.5 algorithms (Oishi & Kaneiwa, 2022). Previous research conducted by Dwi Marisa Efendi and Pakarti Riswanto, titled "Application of Data Mining for Fertilizer Sales Prediction Using the Apriori Algorithm Method," published in the Journal of Information and Computers (Vol. 9, No. 1, 2021), employed the Apriori algorithm method to determine the quantity of fertilizer sold at Fadilah Semuli Jaya shop (Thoyyibah, 2023). In another study, Yogi Yusuf W. conducted a comparative analysis of the performance of the Decision Tree C 5.0, CART, and CHAID algorithms in predicting the credit risk status at Bank X. The findings indicated that the average accuracy rate for the C 5.0 algorithm was 87.72%, while for CART and CHAID, it was 87.27% and 87.15%, respectively (Puji Catur Siswipraptini et al., 2023). Furthermore, a study titled "Application of Data Mining for Sales Prediction of Medical Devices Using the C 4.5 Algorithm at PT. Murni Indah Sentosa" explored classification techniques applied to the analysis of medical device sales transactions. Determining the stock of medical devices aids managers in forecasting future sales. (Fikri & Verina, 2020). Based on these phenomena and challenges, the present study aims to streamline the supply of goods at CV. Mitra Karya Sejati, enhancing inventory planning and making it easier for the company to identify fertilizer products that need to be supplied and are in high demand among consumers using the C 5.0 algorithm.

## 2. RESEARCH METHOD

The waterfall method is one of the software development methods that follows a linear and sequential approach. In this method, each stage depends on the completion of the previous stage, and there is no iteration or going back to a previous stage once the next stage is initiated. The waterfall method is suitable when project requirements are clear and do not change during the development process. This study uses the waterfall method as a method of developing the system that was built. The stages of the waterfall method are depicted in Figure 1 below.

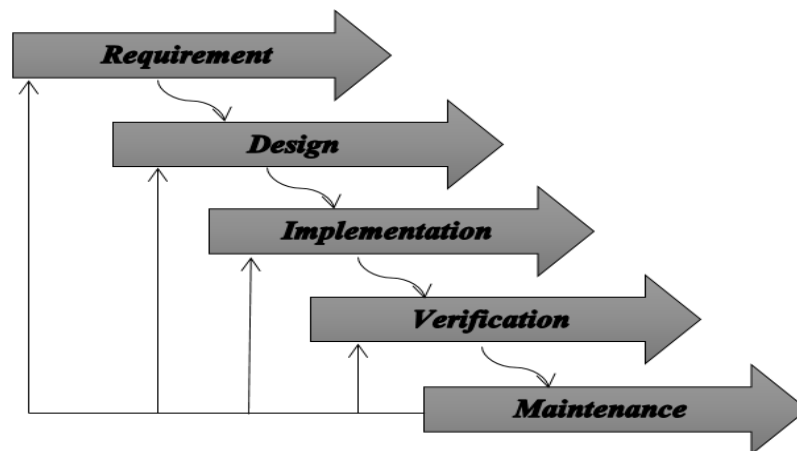


Figure 1. Waterfall Method Stage(Hasibuan & Mahdiana, 2023)

The stages in Waterfall are as follows:

- a. Requirement  
At this stage, system developers need to communicate with users to understand the software and the limitations of the software they expect. Information can be obtained through interviews, discussions or live surveys. The information is analyzed to get the data that the user needs(Shabrilianti et al., 2023).
- b. Design  
At this stage, the developer makes a system design that can help determine the hardware and system requirements and also help determine the overall system architecture.
- c. Implementation  
In this phase, the system is first developed into small programs called units, which are integrated into subsequent phases. Each unit is developed and tested for features called unit tests(Darmawan & Iswari, 2022).
- d. Verification  
In this phase, the system is inspected and tested to see if the system fully or partially meets the system requirements, the tests can be classified as unit testing (performed on a particular code module), system testing (to see how the system reacts when all modules are integrated) and acceptance tests (with or on behalf of the customer to see if all customer requirements are met).
- e. Maintenance  
This is the final step in the Waterfall method. Completed software run and maintained. Maintenance fixes bugs not found in the previous step(Purwanto & Nugroho, 2023)(Attamami et al., 2023) .

The stages in the C 5.0 Algorithm can be seen in Figure 2 below:

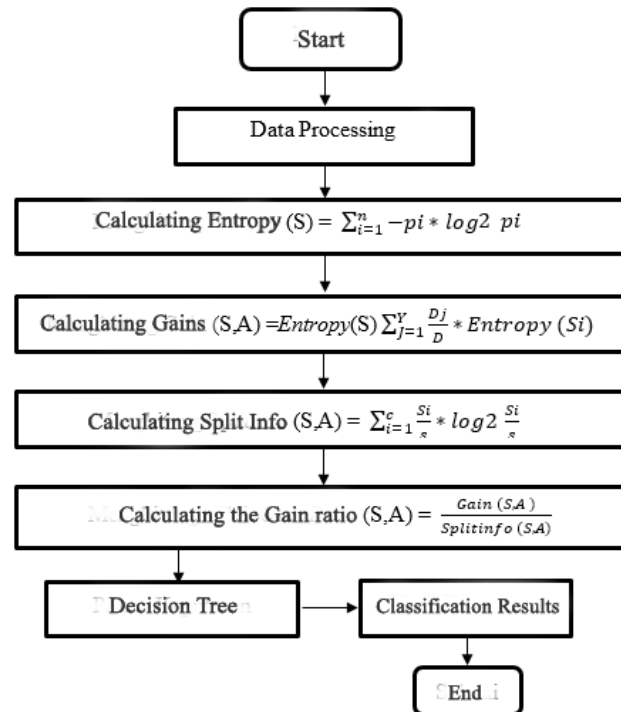


Figure 2. Stage in the C 5.0 Algorithm

This research utilizes the waterfall method by applying the C5.0 method. Figure 2 illustrates the steps that will be undertaken in this study. The initial stage of the research involves using a pre-executed sales dataset. Subsequently, data processing is conducted by calculating the entropy of each attribute within the dataset. Then, the information gain of all attributes is calculated as a whole. The result of these calculations produces splitinfo data for each previously calculated attribute. Furthermore, the gain ratio is computed for each dataset and attribute involved in the research. The gain ratio values will serve as a guide for determining the decision tree in classifying the testing and training data that have been conducted previously.

The first step is data processing, namely the data cleaning process which will then be calculated for Entropy and Gain. Entropy calculation formula is written in equation(1).

$$\text{Entropy (S)} = \sum_{i=1}^n p_i \log_2(p_i) \quad (1)$$

Information:

S : set

A : attribute

n : number of partitions S

pi : the proportion of Si to S(Widiastuti et al., 2022)

The second stage is to calculate the Gain which is written in equation (2) below.

$$\text{Gain (S,A)} = \text{Entropy (S)} \sum_{j=1}^D \frac{D_j}{D} * \text{Entropy (S}_i) \quad (2)$$

Furthermore, the calculation of split information is used to select a number of attributes, with the formula in equation (3) below.

$$SplitInfo(S, A) = \sum_i^c = 1 \frac{S_i}{S} \text{Log}2 \frac{S_i}{S} \quad (3)$$

Where S is the number of sample data and Si is the number of each on each attribute (Karlitasari et al., 2023).

After getting the results of the split information, the next step is to calculate the Gain Ratio which is written in the following equation (4).

$$Gain\ Ratio = \frac{Gain(S,A)}{Split\ Info(S,A)} \quad (4)$$

The following is a Decision Tree development method by utilizing the C 5.0 algorithm: (a) The tree is first given as a single node, which represents the training set. (b) If the same class appears in all samples, the node becomes a leaf and is labeled with that class. (c) Otherwise, the algorithm will select predictor variables based on entropy-based metrics (Information Gain) to divide the data into different classes. At that node, this variable becomes a test or decision variable. (d) For each known value of the test variable, a branch is created, and the sample is partitioned according to that branch. (e) To create a Decision Tree, the algorithm is repeated according to the procedure. (f) Only one of the following conditions must be met for a recursive partition to terminate (Gusti Maulid & Hadiani, 2023): The class of all records on a node is the same, The remaining record characteristics cannot be partitioned again. The majority vote applies in this situation. The node becomes a leaf node, with most of the current record classes indicated (Adli Abdullah, 2021) (Dwita Elisa Sinaga et al., 2022).

### 3. RESULTS AND DISCUSSIONS

#### 3.1 Results of Stages of Algorithm C 5.0

In this study there is a data set with a total of 1356 records, in which the data has 6 attributes and 1 class. The steps to determine the Gain Ratio value are as follows: (a) Calculating the value of Entropy using equation (1), the result of the entropy of the entire class is 0.847618343. (b) Calculating the value of gain information by using equation (2) (c) Calculate the value of Split Info with equation (3), (d) Calculating the Gain Ratio value with equation (4), (e) Build a classification model to form a decision tree

Below are the results of the calculation of each attribute using equations (1), (2), (3), and (4) (Amalda et al., 2022) (Sandi et al., 2023).

Table 1. Gain Ratio Calculation.

Attribute	Informasi Gain	Split Info	Gain Ratio	Rank
Name of Fertilizer	0,037737	5,26530907	0,007167186	
Sales Type	0,001894849	0,84761834	0,002235498	
Unit	0,0000312	0,81244488	0,0000384	
Month	0,063005643	3,28935216	0,019154423	
Year	0,003255712	1,99656532	0,001630656	
Total	0,847618343	7,88465597	0,107502261	1

From the table above, it can be concluded that the highest Gain Ratio lies in the total attribute with a value of 0.10750226 so that it can be taken as a benchmark in the decision tree node.

#### 3.2 Decision Tree

Determining the decision tree is to find the highest Gain Ratio value from all attributes, then create a decision tree root node based on the highest Gain Ratio

value(Ella Sari et al., 2021). From these results, the root node or the first node of the decision tree has been obtained. Figure 3 below is a picture of the decision tree.

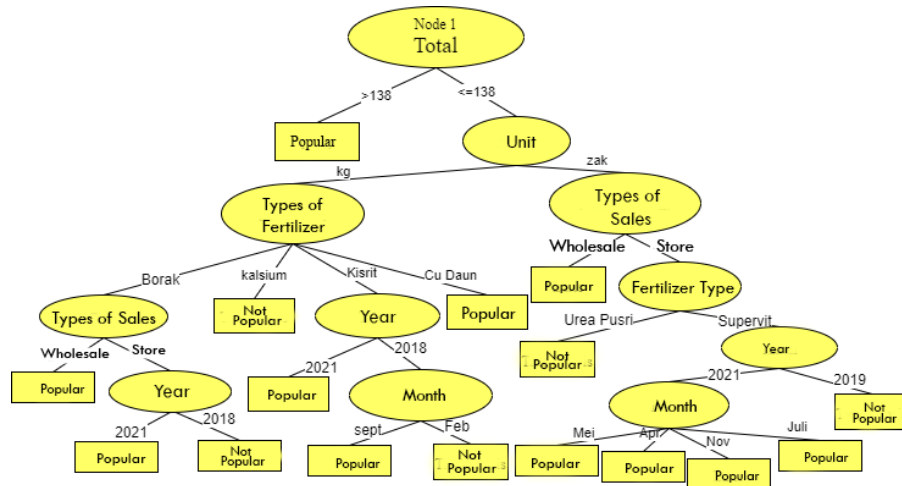


Figure 3. Decission Tree

In Figure 3 it can be seen that the highest gain ratio is total, if total sales are > 138 then sales are selling well, and if total <= 138 then a decision has not been taken because the nodes or roots must be recalculated into the nearest node, so we get the decision tree results from several tree nodes, which will determine the end result.

### 3.3 Confusion Matrix

Confusion matrix is a method for evaluation that uses a matrix table. The results of the evaluation using the confusion matrix produce accuracy, as well as the error rate(Cahya & Sistem, 2020). Accuracy states the amount of data that is classified correctly after the testing process is carried out, while the error rate is used to calculate identification errors(Agustian & Ramadhani, 2022). To calculate the accuracy is:

$$Accuracy = \frac{TP+TN}{TP+FN+FP+FN} \times 100 \tag{5}$$

Where TP is True Positive, namely the number of positive data that is correctly classified by the system, TN is True Negative, namely the number of negative data that is correctly classified by the system, FN False Negative is the number of negative but incorrectly classified by the system and FP is False Positive, namely the number positive data but classified incorrectly by the system(Efendi & Riswanto, 2021). The error rate can be calculated as follows:

$$Laju\ error = \frac{Number\ of\ Data\ Identified\ Incorrectly}{Total\ Data} \times 100 \tag{6}$$

$$Precision = \frac{TP}{TP+FP} \tag{7}$$

$$Recall = \frac{TP}{TP+FN} \tag{8}$$

Where :

TP (True Positive) = Amount of Actual Data = 'Selling' and Predicted = 'Selling'

FN (False Negative) = Total Data Actual = 'Selling' and Predicted = 'Not Selling'

TN (True Negative) = Total Data Actual = 'Not Selling' and Predicted = 'Selling'

FP (False Positive) = Total Data Actual='Not Selling' and Predicted='Not Selling'(Algoritma & Dan, 2023)

Table 2. Confusion Matrix

	Identified Selling	Identified Not Selling
Selling Test Data	193	0
Test Data Not Selling	0	79

From table 2 above, the accuracy level of the classification can be measured as follows:

TP = 193, FN = 0, TN = 79, FN = 0

Accuracy =  $((TP + TN) / (TP+FP+TN+FN)) \times 100\%$

Accuracy =  $((193+79) / (193+0+79+0)) \times 100\%$

Accuracy = 100%

### 1. Attribute Page

This page functions to manage attributes such as adding, editing, and deleting. Figure 4 below is an attribute page view.

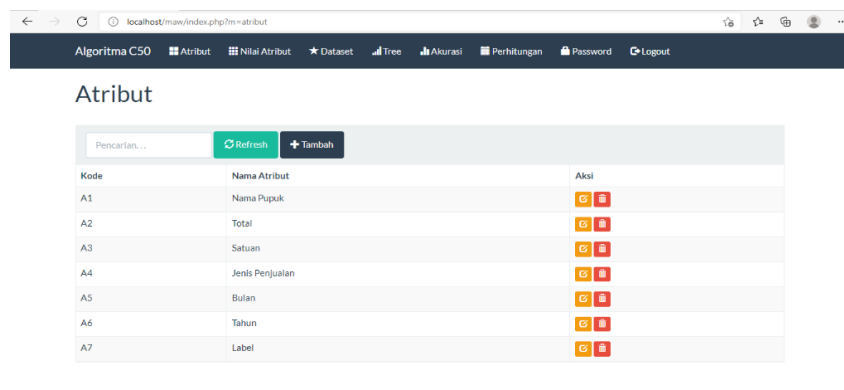


Figure 4. Attribute Page

### 2. Attribute Value Page

This page is a page that displays attribute values and can manage, delete, and edit attribute value data (Melani, 2022). Here's what the attribute values look like:

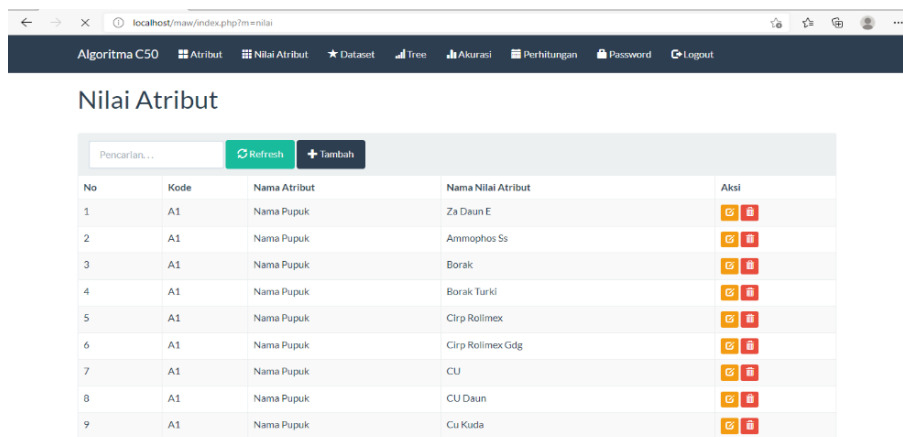


Figure 5. Attribute Value Page

### 3. Dataset Page

The dataset page is a page that can manage, edit, and delete datasets. Below is a display of the dataset page:

Nomor	Nama Pupuk	Total	Satuan	Jenis Penjualan	Bulan	Tahun	Label	Aksi
1	CU Daun	2	zak	Toko	Februari	2021	Tidak Laris	
2	Cirp Rollimex Gdg	32	zak	Grosir	Februari	2021	Tidak Laris	
3	Dolomit	741	zak	Grosir	Februari	2021	Laris	
4	Dolomit Gudang	452	zak	Grosir	Februari	2021	Laris	
5	Kalsium Gudang	225	zak	Toko	Februari	2021	Laris	
6	Kirsit	44	zak	Grosir	Februari	2021	Tidak Laris	
7	Mop Mahkota	620	zak	Grosir	Februari	2021	Laris	
8	Mop Meroke	1251	zak	Grosir	Februari	2021	Laris	
9	Mop Meroke E	115	kg	Grosir	Februari	2021	Laris	

Figure 6. Dataset Page

### 4. Calculation Result Display

This page is a calculation page for C 5.0 algorithm methods such as entropy, gain, splitInfo, and gain ratio (Suprpto et al., 2022). The calculation results page can be seen in Figure 7 below.

No.	Jenis Atribut	Nama Atribut	Nilai	Total	Entropy	Gain	Split Info	Gain Ratio
1	Nama Produk	CU Daun	30	1356	1	0.038	5.273	0.007
2	Nama Produk	Cirp Rollimex Gdg	31	1356	0.771			
3	Nama Produk	Dolomit	53	1356	0.657			
4	Nama Produk	Dolomit Gudang	35	1356	0.513			
5	Nama Produk	Kalsium Gudang	42	1356	0.792			
6	Nama Produk	Kirsit	9	1356	0.764			

Figure 7. Calculation Result Display

### 5. Decision Tree View

The decision tree page is one of the results of the C 5.0 method which makes the classification in the form of a decision tree (Syarif & Nugraha, 2023). Here's what the decision page looks like:

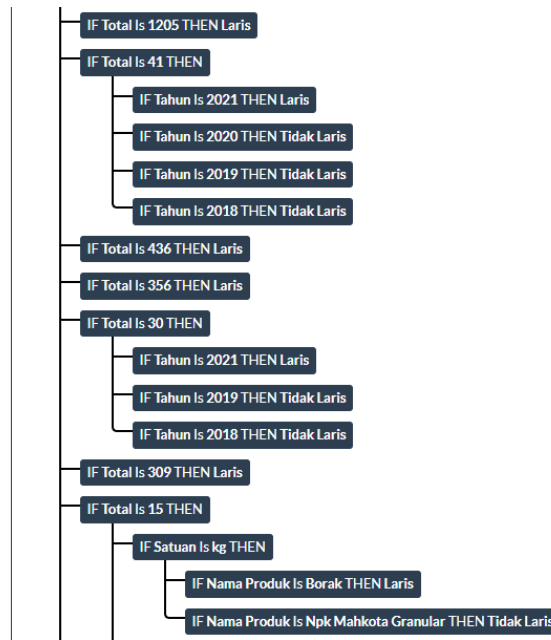


Figure 8. Decision Tree View

### 6. Display Results Accuracy

From the test data, it was found that the accuracy of the best-selling test data was identified as selling well in C 5.0, amounting to 193, identified as not selling well, C 5.0 as being 0. Then, the test data not being identified as selling well as C 5.0 being 0, and being identified as not selling as C 5.0 being 79. So it has an accuracy value of 100%. Can be seen in the image below:

Confusion Matrix, Akurasi, Precision dan Recall		
1. Confusion Matrix		
	Diidentifikasi Laris C.50	Diidentifikasi Tidak Laris C.50
Keputusan data uji Laris	193	0
Keputusan data uji Tidak Laris	0	79

2. Akurasi = 100%

3. Precision = 100%

4. Recall = 100%

Figure 9. Display Results Accuracy

### 7. Prediction Results Display

The prediction results are the final calculation process where the predictions are made based on the training dataset that has been executed, as shown in the following diagram.



Figure 10. Stock Prediction Results

In the figure 10 above, the research results indicate that for the "CU DAUN" product, the total sales in May 2023 amounted to 13 sacks. However, it is predicted that in July 2023, there will be a significant increase in sales, with an estimated 193 sacks sold and an accuracy rate of 100%. This result will serve as a reference for the company to determine the quantity of stock that needs to be prepared for future months, thus avoiding stockpiling of fertilizer in the warehouse.

#### 4. CONCLUSION

This research successfully implemented the C 5.0 Algorithm in designing a data mining application to determine stock planning based on agricultural material sales at CV. Mitra Kerja Sejati. From the implementation of the C 5.0 algorithm, the root node or the first node of the decision tree was obtained. The total sales of CU DAUN product in June 2023 were 193 bags of fertilizer, which were sold successfully. There were no unsuccessful sales recorded. The accuracy rate of the tested data was 100%. The results of the C 5.0 algorithm in this data mining application can assist CV. Mitra Karya Sejati in determining their stock of goods by identifying successful and unsuccessful sales. The entire process in the designed data mining application has been successfully executed and can be functional according to the intended purpose. As a next step in the research development, the researcher suggests conducting future studies by utilizing datasets with a larger number of attributes and adopting the latest research methods. This approach aims to achieve the best possible results when implemented in an Android-based application.

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