



## Application of the Naïve Bayes and K-Nearest Neighbor Methods for Classifying Roses

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### ABSTRAK

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They are faced with the rapid development of plant science, especially the science of rose flora. The rose has a sweet-smelling charm; beautiful color. Many people, like roses, are deliberately cultivated by the beauty industry as the main ingredient in making cosmetics. Roses have various varieties, and the types have similarities, so it is difficult to distinguish, know and determine the varieties of roses; in plain view, it requires a long time and precision. In this study, the Naïve Bayes and K-Nearest Neighbor applications were used. Algorithms will be carried out for the classification of roses in addition to proving the identification and classification of rose varieties based on morphological characteristics using K-NN and Naïve Bayes to understand the diversity of roses. The Naive Bayes method produced maximum accuracy with little training data. Meanwhile, K-Nearest Neighbor was chosen because it is robust against noise data. The performance of the two methods will be compared to determine which method is better for classifying roses. The results show that the Naive Bayes method performs better, with an accuracy rate of 75%, while the K-Nearest Neighbor method has an accuracy rate of 62.5%.

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### 1. INTRODUCTION

Roses have the Latin name *Rosa sp.* is a flower with a fragrant aroma and is much liked by the community (Prayogo et al., 2022). Hundreds of roses are famous in Indonesia, including princesses, musk, and that roses (Sari & Sari, 2022). The plant, which has the Latin name *Rosa sp.*, also has high economic value because it is much needed for raw materials in the perfume, cosmetic, and health industries. Plants that have a variety of colors, shapes, and sizes. It took a long time to recognize the diversity of roses. Therefore, identification needs to be done by classifying roses to understand the differences between the types of roses.

Based on these problems, the process of identifying roses is carried out using the Rapidminer application. Class membership prediction can use this algorithm (syaeful Achmad et al., 2022) using the Naive Bayes algorithm, while the K-Nearest Neighbor (KNN) method is not only used for classification of roses (Utami et al., 2022) (Pratama et

al., 2020) (Meiriyama et al., 2022) because it has a high manifest on accuracy in classifying images of learning data objects based on the closest thing (Prayogo et al., 2022). A simple classification method in several entities, such as the Naive Bayes method (Marthin Luther Laia & Yudi Setyawan, 2020), (Manik & Saragih, 2017), (Syaeful achmad et al., 2022), can contribute to the final decision. Each attribute has an independent nature (Riadi et al., 2019). Meanwhile, the K-Nearest Neighbor (K-NN) method is a classification method that classifies objects based on learning data that is closest to the thing. Understanding data is projected into a multi-dimensional space, where each dimension represents a data feature (Liantoni & Nugroho, 2015).

As time goes by, technological developments (Anugroho et al., 2005) and digital image processing techniques are developed to facilitate human work. Digital image processing is also often used to identify an object to obtain an ideal image (Liantoni & Cahyani, 2017). Therefore, to find out the structural form of the rose image, which is then modified by feature extraction in digital image processing. A feature extraction process is needed with the introduction of digital morphological features to obtain the shape of a rose structure. In this study, the feature extraction used is the same as (Karuni Ayuningsih, 2018): color feature extraction using the HSV (Hue, Saturation, Value) method. The HSV method elaborates the Hue, Saturation, and Value values. Hue is the actual color or shape identity from degrees 0-360. saturation determines the amount of white light mixed with a hue, while the value is the brightness of a color whose value is 0-100% (Syam et al., 2021).

The K-Nearest Neighbor method is used for classification (Farokhah & Correspondence, 2020). It does not require many datasets and is easy to implement and fast in processing data. However, if the data scale size and dimensions are significant, it can cause noise in the dataset, affecting the classification accuracy results.

In the study (Farokhah & Correspondence, 2020), improvements were made to the dataset by filtering the non-representative data set to reduce noise. This can petrify the value of accuracy in the data set and prevent the curse of dimensionality that can affect classification performance.

However, these two methods have their advantages and disadvantages. The Naïve Bayes algorithm has benefits, including, it can handle quantitative data as well as discrete data, both for isolated data, it only requires a small amount of data to estimate parameters for classification, it can handle values which is lost by ignoring instances during the calculation of opportunity estimation, fast and efficient and capable of irrelevant attributes, while the drawback is that it does not apply if the conditional probability is zero if it is zero then the prediction is also zero, the variable is independent. Whereas the K-NN algorithm has advantages; namely, it is easy to implement and easy to adapt. It has few hyperparameters, while the disadvantages of K-NN are that it is not suitable for datasets with large numbers, high dimensions, sensitivity to noise, missing values, and outliers.

In this study, the application of the Naïve Bayes and K-Nearest Neighbor. Algorithms will be carried out for the classification of roses in addition to proving the identification and classification of rose varieties based on morphological characteristics using K-NN and Naïve Bayes to understand the diversity of roses. The Naive Bayes method produced maximum accuracy with little training data. Meanwhile, K-Nearest Neighbor was chosen because it is robust against noise data. The performance of the two methods will be compared to determine which method is better for classifying roses.

## 2. RESEARCH METHOD

The stages of the research that will be carried out in this study are shown in Figure 1, where it can be explained that the initial step starts with taking pictures from various existing sources on the internet, especially from Pinterest, which provides multiple

images of roses but cannot be classified or grouped on the type of flower. In this study, only red and white pictures of roses were used, and later these flowers would be classified using the Naïve Bayes and K-NN methods. This study used two ways to compare which method has better accuracy for classifying roses.

Figure 1 below explains the research flow and digital images from internet sources. This process can involve adjusting parameters such as exposure, shutter speed, or resolution to ensure optimal image quality. The first step is to prepare image data to be used for classification. This data must be separated into training data and testing data. In addition, the data must also be arranged in the proper format to be processed by the Naive Bayes and K-NN methods. After the image data is ready, the next step is to perform feature extraction on the data. The extracted features include statistics, shapes, colors, textures, or combinations. These features will be used as variables in the Naive Bayes and K-NN methods. The next step is classification with K-NN: Classify the testing data using the K-NN method with a predetermined K value. Calculate the accuracy of the K-NN classification results and classification with Naive Bayes: Perform type-on-data testing using the Naive Bayes method. Calculate the accuracy of the results of the Naive Bayes classification. Compare the accuracy of the classification results in two ways. With matrix coefficients, Select the method that provides the highest accuracy as the most suitable method for the classification of image data used.

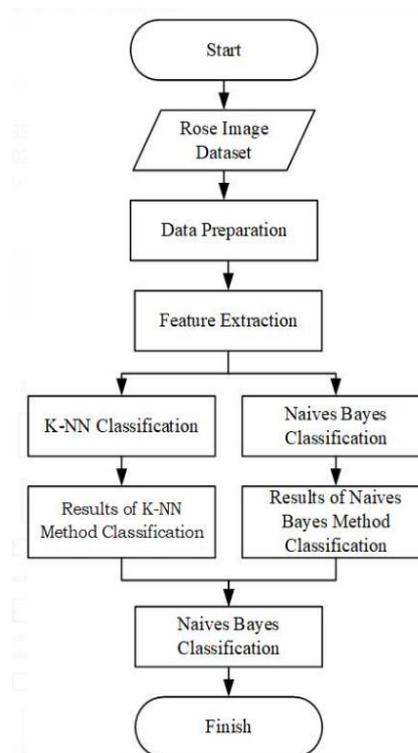


Figure 1. Research Flowchart

This study begins with data collection techniques that will be used, namely by collecting various pictures of roses found on the internet and taking pictures of roses using a digital camera. The data that was collected was 50 roses of multiple forms. This study used the types of roses, princess and rose Thalita, with red and white colors, some of which are shown in Figure 2. In Figure 2. Shows image data for roses taken from Pinterest.

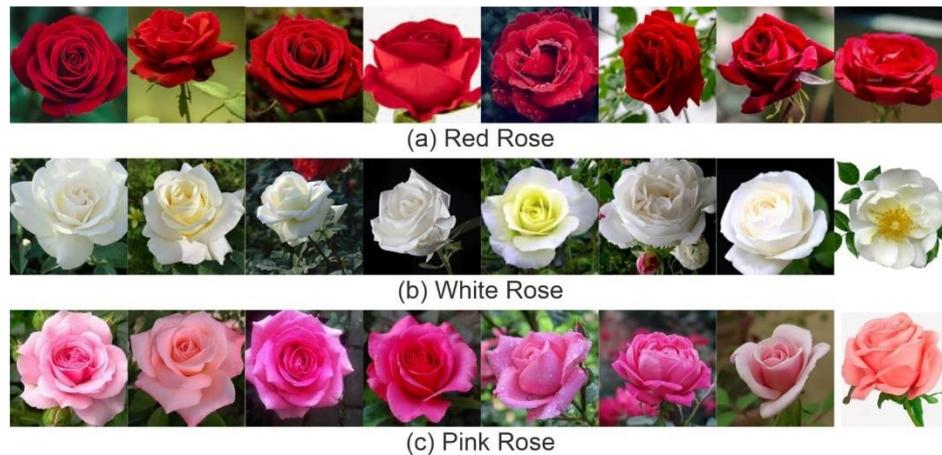


Figure 2. Rose Image Data taken

Then select the image of a rose that is adjusted to the research needs, namely the appearance of a rose that is not deformed in either shape or color and adapted to the size in jpg form. From the collected rose image data, feature extraction is performed using feature extraction to normalize the intensity of lighting on RGB or Red Green, Blue color images using Matlab, then the results obtained from the extraction are identified or grouped using the Naïve Bayes and K-NN methods.

While the separation of training data and testing data from rose images, that is, from a total of 50 rose images obtained, divided manually into 40 images for training data and 10 rose images for testing data which was carried out using the Rapidminer application. The division is as in Table 1.

| Row | Types of Roses | Data Training | Data Testing |
|-----|----------------|---------------|--------------|
| 1   | Red Rose       | 20 Images     | 5 Images     |
| 2   | White Rose     | 20 Images     | 5 Images     |
|     | Dataset        | 40 Images     | 10 Images    |
|     | Total          |               | 50 Images    |

Methods K-NN and Naive Bayes are two classification techniques commonly used in machine learning. Both methods are instrumental in classifying data based on a given attribute and can help understand the relationship between different variables in a dataset.

Accurate and representative data collection techniques are crucial for reliable results in an analysis using the K-NN and Naive Bayes methods. This analysis was carried out by applying the K-NN and Naive Bayes methods to a dataset of 50 images with two different types of shots. The K-Nearest Neighbor algorithm is a classification method that measures the distance between the test data and the training data, looking for as many as k training data that are closest to the test data; this distance is calculated using the Euclidean distance formula, whose equation is as in equation 1.

$$d(X_{ij}, Y_i) = \sqrt{\sum_{i=1}^n (X_i - Y_i)^2} \quad (1)$$

Where:

d = distance between data

$X_{ij}$  = sample of data

$Y_i$  = testing data

i = variable of data

n = dimension of data

The Naïve Bayes algorithm as a classification method is also often used besides K-NN because it is equally easy and has good results for various classification cases. The equation of this algorithm is as in Equation 2

$$P(X|H) = \frac{P(X|H).P(H)}{P(X)} \quad (2)$$

Then the method used to estimate the work of the classification procedure uses a confusion matrix. The results compare the actual classification results (Prasetyo 2012). Four terms are used to represent the results of the classification, which are shown in Table 2.

Table 2. Representation of Confusion Matrix Classification Process Results

| Representation Results | Information  |
|------------------------|--|
| True Positive (TP)     | The system correctly classifies total positive data.                         |
| True Negative (TN)     | The system correctly classifies the total negative data.                     |
| False Negative (FN)    | The total data is positive but is classified as negative data by the system. |
| False Positive (FP)    | The total data is negative but is classified as positive data by the system. |

Source: (Heydarian et al., 2022)

The classification model was evaluated using accuracy, namely the ratio of correct predictions to the total predictions; precision, the balance of the accurate positive predictions to the total positive predictions, and recall, namely the percentage of positive predictions to the positive data. The equations are as in equations 3, 4, and 5.

$$Akurasi = \frac{TP+TN}{TP+FP+TN+FN} \times 100\% \quad (3)$$

$$Presisi = \frac{TP}{FP+TP} \times 100\% \quad (4)$$

$$Recall = \frac{TP}{TP+FN} \times 100\% \quad (5)$$

### 3. RESULTS AND DISCUSSIONS

Feature extraction resulting from HSV feature extraction, this study normalizes the intensity of lighting on RGB color images. The results of the rose flower feature extraction values are seen in Table 3 and Figure 3.

Table 3. HSV Feature Extraction Test Data Results

| Row | Flower Color | Test 1 | ... | ... | Test 6 |
|-----|--------------|--------|-----|-----|--------|
| 1.  | Red          | 107,49 | ... | ... | 0,086  |
| ... | ...          | ...    | ... | ... | ...    |
| ... | ...          | ...    | ... | ... | ...    |
| 10. | White        | 148,15 | ... | ... | 0,070  |

Meanwhile, the percentage increase in the graph of the feature data test using the rapid miner application is shown in Figure 3. The feature process was carried out six times, and the results from the feature one graph found numbers up to more than 100, and feature 2 found the process reached almost 100.

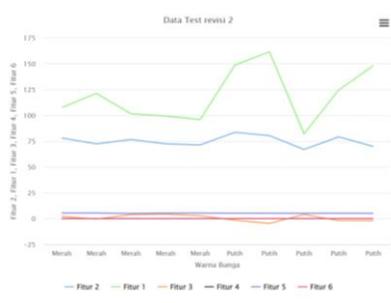


Figure 3. Graph of HSV Feature Extraction Train Data Results

While the results of the training data for feature extraction on HSV using the Rapidminer application are shown in Table 4 and Figure 4.

Table 4. HSV Feature Extraction Train Data Results

| Row | Flower Color | Test 1 | ... | ... | Test 20 |
|-----|--------------|--------|-----|-----|---------|
| 1.  | Red          | 0,00   | ... | ... | 0,00    |
| ... | ...          | ...    | ... | ... | ...     |
| 40. | White        | 0,00   | ... | ... | 0,00    |

In Figure 4. Shows the feature graph of the data train using Rapidminer. The results obtained from the chart show that there is a feature process progress with the highest percentage of 725 and the lowest at the limit of 0.

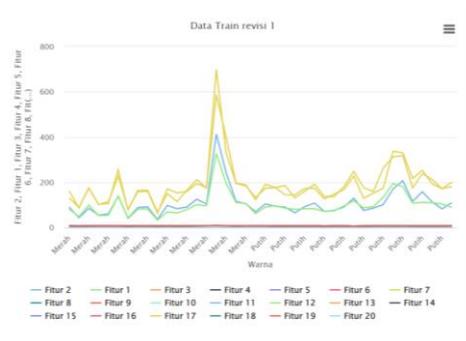


Figure 4. Graph of Features from Train Data

In this study, from the feature extraction of the data obtained, the data testing process was carried out to determine the probability of success of the classification performance using the Naïve Bayes algorithm and compared it with the K-Nearest Neighbor algorithm on rose images. The testing process for the Rapidminer is shown in Figure 5.

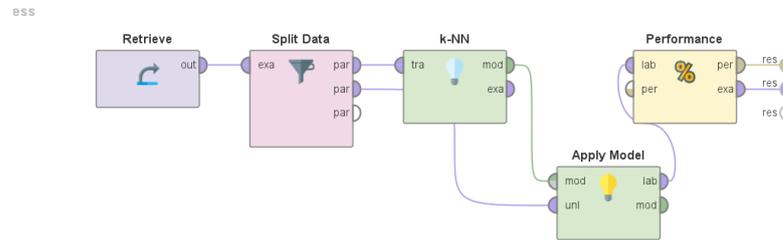


Figure 5. Modeling the K-NN method

Likewise, the testing process was carried out on the Naïve Bayes algorithm. Both algorithms divide the data into training and testing data using split data. The separated data used is a ratio of 80: 20, which is then carried out to compare the accuracy or evaluation results of the performance between the K-Nearest Neighbor and Naïve Bayes algorithms. Figure 7 shows the results of classifying the Naïve Bayes method from the data train using the Rapidminer.

**accuracy: 75.00%**

|              | true Merah | true Putih | class precision |
|--------------|------------|------------|-----------------|
| pred. Merah  | 4          | 2          | 66.67%          |
| pred. Putih  | 0          | 2          | 100.00%         |
| class recall | 100.00%    | 50.00%     |                 |

Figure 6. Classification results of Naïve Bayes data train

Figure 8 shows the data train has run the Naïve Bayes classification process, and there are results of the prediction of the type of flower from Rapidminer.

| Row No. | Warna | prediction(...) | confidence(...) | confidence(...) | Fitur 1 | Fitur 2 | Fitur 3 | Fitur 4 |
|---------|-------|-----------------|-----------------|-----------------|---------|---------|---------|---------|
| 1       | Merah | Merah           | 1.000           | 0.000           | 0.000   | 138.535 | 0.226   | 8.583   |
| 2       | Merah | Merah           | 0.987           | 0.013           | 0.002   | 42.461  | 0.345   | 7.722   |
| 3       | Merah | Merah           | 0.996           | 0.004           | 0.001   | 98.655  | 0.291   | 8.386   |
| 4       | Merah | Merah           | 0.993           | 0.007           | 0.001   | 116.669 | 0.271   | 8.263   |
| 5       | Putih | Putih           | 0.032           | 0.968           | 0.001   | 94.673  | 0.419   | 8.011   |
| 6       | Putih | Putih           | 0.318           | 0.682           | 0.001   | 90.463  | 0.355   | 7.903   |
| 7       | Putih | Merah           | 0.533           | 0.467           | 0.001   | 65.181  | 0.382   | 7.852   |
| 8       | Putih | Merah           | 0.923           | 0.077           | 0.001   | 115.882 | 0.329   | 8.136   |

Figure 7. Results of Color Accuracy Prediction Data Train Data Naïve Bayes method

The recall indicator (R) calculation result is only 50% for precision rate indicators (p) up to 100%. For the Accuracy indicator (A), roses have the same value of 75%. Figure 9 shows the results of the Naïve Bayes classification method from test data using the Rapidminer.

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accuracy: 100.00%

|              | true Merah | true Putih | class precision |
|--------------|------------|------------|-----------------|
| pred. Merah  | 1          | 0          | 100.00%         |
| pred. Putih  | 0          | 1          | 100.00%         |
| class recall | 100.00%    | 100.00%    |                 |

Figure 8. Classification results of the Naïve Bayes Data Test

Figure 9 shows that the test data has carried out the Naïve Bayes classification process, and there are results of predicting the type of flower from Rapidminer.

| Row No. | Warna Bunga | prediction{... | confidence{... | confidence{... | Fitur 1 | Fitur 2 | Fitur 3 | Fitur 4 |
|---------|-------------|----------------|----------------|----------------|---------|---------|---------|---------|
| 1       | Merah       | Merah          | 0.991          | 0.009          | 107.490 | 78.089  | 2.208   | 0.005   |
| 2       | Putih       | Putih          | 0.000          | 1.000          | 161.594 | 80.407  | -4.587  | 0.006   |

Figure 9. Color Accuracy Prediction Data Results in Naïve Bayes Method Test Data

While the calculation results with indicators recall (R), precision rate (p), and Accuracy (A) of roses that have the same value produce a perfect accuracy value of 100%. Figure 10 shows the K-NN method classification results from the data train using the Rapidminer.

accuracy: 100.00%

|              | true Merah | true Putih | class precision |
|--------------|------------|------------|-----------------|
| pred. Merah  | 1          | 0          | 100.00%         |
| pred. Putih  | 0          | 1          | 100.00%         |
| class recall | 100.00%    | 100.00%    |                 |

Figure 10. K-NN Data Train Classification Results

Figure 11 shows the data train that has run the K-NN classification process and has the results of predicting the type of interest from Rapidminer.

| Row No. | Warna | prediction{... | confidence{... | confidence{... | Fitur 1 | Fitur 2 | Fitur 3 | Fitur 4 |
|---------|-------|----------------|----------------|----------------|---------|---------|---------|---------|
| 1       | Merah | Putih          | 0.372          | 0.628          | 0.000   | 138.535 | 0.226   | 8.583   |
| 2       | Merah | Merah          | 1              | 0              | 0.002   | 42.461  | 0.345   | 7.722   |
| 3       | Merah | Merah          | 0.808          | 0.192          | 0.001   | 98.655  | 0.291   | 8.386   |
| 4       | Merah | Putih          | 0.419          | 0.581          | 0.001   | 116.669 | 0.271   | 8.263   |
| 5       | Putih | Putih          | 0.422          | 0.578          | 0.001   | 94.673  | 0.419   | 8.011   |
| 6       | Putih | Putih          | 0.389          | 0.611          | 0.001   | 90.463  | 0.355   | 7.903   |
| 7       | Putih | Putih          | 0.379          | 0.621          | 0.001   | 65.181  | 0.382   | 7.852   |
| 8       | Putih | Merah          | 0.609          | 0.391          | 0.001   | 115.882 | 0.329   | 8.136   |

Figure 11. Results of Color Accuracy Prediction Data for K-NN Method Train Data

Calculation results with indicators recall (R), precision rate (p), and Accuracy (A) of roses that have the same value produce an accuracy of up to 100%. Figure 12 shows the results of the K-NN method classification from the test data using the Rapidminer.

accuracy: 62.50%

|              | true Merah | true Putih | class precision |
|--------------|------------|------------|-----------------|
| pred. Merah  | 2          | 1          | 66.67%          |
| pred. Putih  | 2          | 3          | 60.00%          |
| class recall | 50.00%     | 75.00%     |                 |

Figure 12. Classification Results of K-NN Data Test

Likewise, Figure 13 shows the test data that has carried out the K-NN method classification process, and there are results of the prediction of flower types from Rapidminer.

| Row No. | Warna Bunga | prediction(...) | confidence(...) | confidence(...) | Fitur 1 | Fitur 2 | Fitur 3 | Fitur 4 |
|---------|-------------|-----------------|-----------------|-----------------|---------|---------|---------|---------|
| 1       | Merah       | Merah           | 0.821           | 0.179           | 107.490 | 78.089  | 2.208   | 0.005   |
| 2       | Putih       | Putih           | 0.350           | 0.650           | 161.594 | 80.407  | -4.587  | 0.006   |

Figure 13. Classification Results of K-NN Data Test

The results of calculations with the recall indicator (R) of the acquisition value reach 75%, for indicators precision rate (p) is only 60%. For the Accuracy (A) indicator, roses have the same value of 62.5%. The results of evaluating the classification process carried out using the Naïve Bayes and KNN methods are shown in Table 4.

Table 5. Evaluation Results

| Roses     | Naïve Bayes |      | K- NN |       |
|-----------|-------------|------|-------|-------|
|           | Train       | Test | Train | Test  |
| Recall    | 50%         | 100% | 100%  | 75%   |
| Precision | 100%        | 100% | 100%  | 60%   |
| Accuracy  | 75%         | 100% | 100%  | 62,5% |

From the research conducted by conducting experiments on 50 images of roses, showing the accuracy and prediction results from testing using the Naïve Bayes method and the K-NN method, a value of 100% was obtained on the test results on Naïve Bayes and the train results on the K-NN method. While the accuracy value for the Naïve Bayes data train method is  $6/8 = 75\%$ , and the accuracy value for the K-NN data test method is  $5/8 = 62.5\%$ .

#### 4. CONCLUSION

After applying the Naïve Bayes and K-Nearest Neighbor methods for the classification of roses, it was found that the performance of the Naïve Bayes method was better than the K nearest Neighbor method. This can be seen from the classification results of 50 rose images with a ratio of 80% as training data and 20% as training data. Then do further grouping to determine the type of rose. From testing the data using both methods, it can be concluded that the results of the Naïve Bayes method yield an accuracy of 75%, while the results of the accuracy of the K-NN method yield an accuracy of 62.5%. This is due to the amount of data in the data preprocessing process, so for the following process, it is advisable to add to the data set and complete the preprocessing stages, such as selecting and filtering data for further research.

The contribution and implication of this research are to generate knowledge about the best method from a comparison of the methods used from naïve Bayes and k nearest neighbors for classifying rose varieties so that they can help rose enthusiasts to get to know and understand more about the types of roses.

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