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COMPARISON OF DECISION TREE AND NAÏVE BAYES ALGORITHMS IN PREDICTING STUDENT GRADUATION AT YPK JUNIOR HIGH SCHOOL, NABIRE REGENCY

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Abstract

This study aims to compare the accuracy of the Decision Tree C4.5 and Naive Bayes algorithms in predicting student graduation at YPK Immanuel Nabire Junior High School, Central Papua. Student data from the 2022 and 2023 school years were used as training data, whereas student data for the 2024 school year were used as testing data. Data collection methods included field studies, interviews with schools, and literature studies. The implementation of the algorithm is carried out using the Orange software, which simplifies the process of data visualization and analysis. Both algorithms are applied to data processed through stages of cleaning and normalization to ensure the quality and relevance of the data used. The results show that the Decision Tree C4.5 algorithm has a prediction accuracy of 90.91%, while the Naive Bayes algorithm has an accuracy of 63.64%. The C4.5 Decision Tree algorithm is superior in predicting student graduation compared to Naive Bayes, which means that the C4.5 Decision Tree is more effective in identifying students who are likely to pass or not pass. The implementation of the C4.5 Decision Tree algorithm also helps schools make better decisions to support students who require additional attention. The study concluded that the Decision Tree C4.5 algorithm is recommended for use in predicting student graduation because it provides higher accuracy. The results of this research can be used by schools to improve the efficiency of the graduation prediction process and develop more effective and efficient learning programs. Using the right algorithms, schools can be more proactive in identifying students who need additional support, which can reduce academic failure rates and improve the overall quality of education.

Keywords: *Prediction, Decision Tree, Naive Bayes, YPK Tabernacle Nabire Junior High School, Central Papua*

1. INTRODUCTION

Education in the life of a nation and state is very important because it is the source of the progress of a nation. With good education, the quality of a nation's human resources can be improved, which is the main asset for building a nation[1]. Junior High School (SMP) is a formal education unit that is organized at the secondary education level. Continuation of primary education or other forms of equivalent study or continuation of learning outcomes are recognized as same or comparable to elementary school[2]. Educational Process Standards are national educational standards related to the implementation of learning An educational unit meets the Graduate Competency standards (Government Regulation No. 19 of 2005 Chapter 1 article 1 Paragraph 6) The National Examination is a deliberate assessment by the government of learning outcomes Assessing the achievement of national level graduate competencies for certain subjects in the science and technology group[3]. Manual prediction of student graduation, which is generally done by teachers or school staff, has several drawbacks, including Subjectivity is Manual prediction is often influenced by the bias and personal opinions of teachers or school staff, which can result in inaccurate and unfair results; inefficiency in manually predicting student graduation can take a lot of time and effort, especially for schools with a large number of students; lack of consistency and manual predictions can vary between teachers or school staff, which can cause confusion and unfairness for students; in addition to data limitations, manual predictions often only consider easily available data, such as test scores and attendance, and do not consider other factors that may affect student graduation, such as socioeconomic background, motivation, and learning style.

Predicting student graduation is the process of using data-mining methods and statistical analysis to determine the graduation rate of students in schools[4]. Predicting student graduation goals can help them determine their learning goals. Student graduation predictions can identify factors that affect student graduation and can be used to help schools solve problems more easily[5]. Predicting students' future performance is important in the context of education. This can help educators and school administrators identify students who may need additional attention or special assistance[6]. The Decision Tree and Naive Bayes algorithms are two methods used to predict student graduation[7]. A decision tree is a data-processing method that builds a decision tree using attribute value values. The Naive Bayes Algorithm is

a classification method that uses probability theory to predict a member's class based on current experience[8]. Researchers are currently applying these two methods to predict student graduation [9]. In this study, the decision tree and naïve Bayes algorithms were used to predict student graduation. The results of the data tests were highly accurate. This shows that the decision tree and naïve Bayes algorithms can be used to predict student graduation with high accuracy[10]. In the application of these two methods, data mining is used as a data processing process that aims to find relationships and behaviors that are not visible in the data. This algorithm uses student data, including personal, academic, and learning data [11]. The comparison between the decision tree algorithm and naïve Bayes in predicting student graduation is related to the way each algorithm works and the power of each algorithm. [12] Decision tree and Naïve Bayes algorithms are currently popular because of their high level of accuracy. Therefore, this study aims to compare the accuracy of the Naïve Bayes algorithm and decision tree algorithm [13]. In the study of predicting the graduation of previous students using many methods, including decision tree, naïve Bayes, and KNN, the advantages and disadvantages of each of these methods, and decided to make a comparison between the Decision Tree and Naive classification methods were compared in predicting student graduation[18]. The newness of the comparative research of the C4.5 and Naïve Bayes decision tree algorithms can be seen in; the decision tree algorithm has an accuracy of 90.91%, while the Naïve Bayes algorithm has an accuracy of 63.63%. In applying the decision tree and naïve Bayes algorithm methods to the orange software, it is easier to predict student graduation, so that the results of student graduation predictions for YPK Immanuel Nabire Junior High School Central Papua are more accurate and have high accuracy so that it can help the school to build a more effective and efficient learning program to reduce student graduation failures. Based on the research that has been conducted, the C4.5 decision tree algorithm is more accurate and has higher accuracy compared to Naive Bayes in predicting student graduation; therefore, this study recommends that the C4.5 decision tree algorithm is feasible for use in predicting student graduation. This research can be useful in taking steps to increase the percentage of student graduation rates and to prevent early student academic failure in school[15]. In addition, it predicts achievement of student graduation. This study aims to compare the performance of decision tree and naïve Bayes algorithms in predicting student graduation in Software Orange and determine which algorithm is more effective in predicting student graduation achievement. [16] Student graduation prediction research using a machine learning algorithm decision tree and naïve Bayes can help schools improve their efficiency in predicting student graduation.

2. RESEARCH METHOD

Research methods are scientific methods to obtain data for specific purposes and uses. When conducting research, we need to follow the applicable rules or rules so that the research results obtained can be considered valid. The research method systematically involves direct observation in the field, and the data collection obtained is then analyzed using statistical techniques to find correlations between the variables studied. In this study, the two algorithms were compared as the best algorithms. The analysis was ranked to predict the graduation of YPK Immanuel Junior High School students in Nabire Regency, Central Papua, using the decision tree method and Naïve Bayes by prioritizing the orange tools. The flow of this study is shown in figure 1.

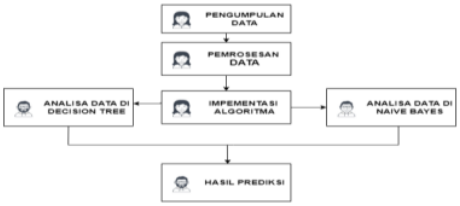

Figure 1. Research Flow

2.1 Data Collection

Data collection is carried out to obtain the necessary information or materials because data are needed to support the prediction of student graduation and learning materials. Collect historical data on YPK Immanuel Junior High School students in Nabire Regency, including academic grades (exam scores). The data collection steps were as follows:

a. Field Study

The author carried out a field study at YPK Immanuel Junior High School, Nabire Regency, for approximately one month. From July 12 to August 15, 2023, in this field study, the author was placed in the computer LAP room and taught ICT subjects in grades XIII & IX[10], so that the author could understand how to teach and know the problems that exist in the school, namely; One of them is that teachers experience obstacles to see the quality of student graduation

b. Interview

The method of collecting data through interviews is carried out through a direct and structured dialogue process between the researcher and the data source, or resource person, namely the principal of the school, P. Yetty Korowa. The purpose of this interview is to take student data that will predict graduation and data taken, namely, in the class of 2022 & 2023 class IXA, 40 students as training data and class IXA students of the class of 2024 are 11 students as test data

c. Literature studies

This method was used to find relevant summaries or facts needed in this study, which were mainly sourced from reference book readings. Articles in previously published research journals. The purpose is to collect data that will be used in the development of the system and all aspects related to the decision tree and Naive Bayes algorithms.

2.2 Data Processing

At this stage, process the data that have been collected so that rules are formed that will be decisions. Before the data in orange connect to the decision tree, the collected data are first cleaned . Data cleaning is carried out to determine which data are used because, at the beginning, there are many attributes so that attributes that are not needed and not processed in the decision tree in this study. The author cleaned the data, such as in the data there is NIM, parents' names, addresses and several other attributes are deleted because these attributes are not needed in this study.

Data processing includes cleaning missing or inconsistent values. By normalizing numerical data by converting categorical data into numerical data, this effort was made to improve and prepare for processing. It considers data collection, data processing, and data cleansing unnecessary in predicting student graduation. The collected data were ided into two sets: data training and data testing. The data mining process uses the C4.5 and Naïve Bayes decision tree algorithms to predict student graduation with high accuracy.

2.3 Algorithm Implementation

The next stage of this study is to implement the algorithm. The implementation of this algorithm is carried out with orange software, connecting the decision tree and naïve Bayes tools to pred ion using data testing, which analyzes the data using the decision tree and naïve Bayes algorithms.

a. Data Analysis Using The Decision Tree Method

At his stage, the data analysis was performed using the decision tree algorithm. In general, the stages of the decision tree algorithm i olve building a decision tree by selecting attr es as the root and then branches for each value. The decision tree algorithm is a supervised learning algorithm used to create classification models. This algorithm uses the attribu listed in the data to form a tree, where each mode in the tree is a decision based on the value of a certain attribute. The decision tree algorithm can be used to predict student graduation using attributes, such as name, subject grade, grade point average, and graduation status.

In general, the decision tree algorithm to build a decision tree involves several stages, namely, preprocessing data training. The tr ing data are taken from historical data that have been grouped into rtain classes, after preparing the next data to determine the root of the tree to calculate the highest gain value of each attribute or based on the lowest entropy index value. Previously, the entropy index value was calculated first with the formula

$$\mathrm{I(S)}\sum_{i=1}^{n} = \frac{|Si|}{|S|}\log_2 \quad \frac{|Si|}{|S|} \tag{1}$$

where S is the set of cases, Si is partition i, n is the number of partitions nd |S| is the number of cases in S. After calculating the entropy value, the gain value is calculated using the following formula:

$$\mathrm{Gain} = \mathrm{I(S)} - \sum_{i=1}^{n} = \frac{|Si|}{|S|}\ l(Si) \tag{2}$$

Information :
S: case set
A: Attribute
n: number of partitions attribute
A |Si |: number of cases in the ith partition
|S|: number of cases in Before

In analyzing this decision tree, it will analyze what attributes are needed in the decision tree algorithm, so that according to the needs, data is prepared and what level of accuracy is produced in predicting student graduation using the decision tree algorithm, which can effectively predict student graduation and help the initial identification of students who are likely not to pass, so as to a w appropriate remediation and retention policies. The C4.5 Decision Tree algor m accurately predicts student graduation rates with a high degree of accuracy, thus helping schools to develop policies and reduce barriers.

b. Data Analysis Using The Naïve Bayes Method

Analyzing the data at this stage is the same as the ta used in data analysis using a decision tree algorithm. The naive Bayes algori is a probability-based data-processing method. The Naive es algorithm can be used as a supporting algorithm in the process of creating a decision-tree classification model. The naïve Bayes algorithm c e used to help select attributes that are important in the process of creating a decision tree. The Nave Bayes algorithm can effective predict student graduation, so it will analyze the level of accuracy generated from the decision tree algorithm to help identify students who are likely not to graduate early, thus enabling appropriate remediation and retention policies. In general, the formula commonly used to calculate the probability of graduation events based on attribute attributes is as follows:

$$\mathrm{P(X|H)} = \frac{P(X|H) - P(H)}{P(X)} \tag{3}$$

Information:

X : Data with unknown classes
Q : The X data hypothesis is a specific class
P(H|X) : Probability of hypothesis H based on condition X (posteriori probability)
P(H) : Probabilitas hipotesis H (posteriori probability)
P(X|H) : Probability X based on the conditions in hypothesis H
P(X) : Probability X

2.4 Prediction Results

At this stage, we will explain the results of predicting student graduation with high accuracy using each of the decision tree and naïve Bayes algorithms to compare the two algorithms to determine the best algorithm for predicting student graduation.

3. RESULT AND DISCUSSION

The image shows the user interface (UI) of the Orange Data Mining Software. The relationships between the widgets in figure 2 show the process of building and evaluating the decision tree and Naive Bayes classification models. Training data were used to build the model and test data were used to evaluate the model's performance. The prediction results are displayed in various formats, including decision trees and prediction tables.

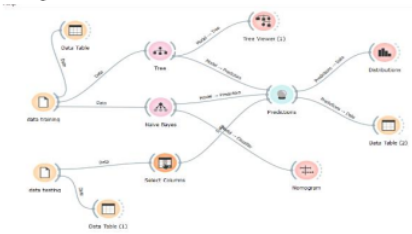

Figure 2. user interface (UI) of the Orange Data

3.1 Data analysis using the Decision tree method

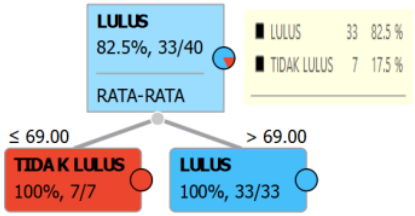

Figure 3: Decision tree model

Based on the analysis of the decision tree shown in figure 3, the exam results show that most of the participants had successfully passed. The second analysis showed that all participants who took the exam, with a minimum score of 69, successfully passed. This shows that the graduation standards set are quite high, and only participants who really master the exam material can pass. The analysis of passing and not passing in a total of 40 participants showed that the number of participants who passed was 33 people with a passing percentage of 82.5%, and the number of participants who did not pass as many as seven people with a percentage of unsuccessful passing of 17.5%. This analysis showed that most participants successfully passed the exam, and only a few participants did not pass the exam.

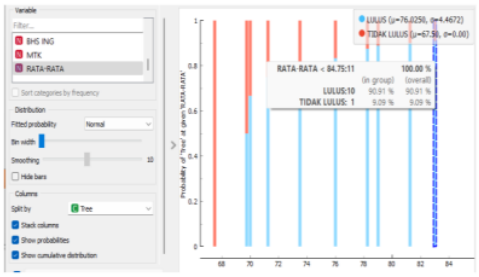

Figure 4. Graph of data analysis results with Decision T

Based on figure 4, the results of the analysis using the decision tree algorithm based on the training data are predicted to have an accuracy level of 90.91% and an error value of 9.09%, which shows that the prediction of class IXA students who will graduate in 2024 is 10 students, and one student is predicted not to graduate. The red color in the graph indicates that students have the potential to not pass the average score of the attributes. On the other hand, blue indicates that students are predicted to have the potential to pass the average score in attributes.

3.2 Data analysis using the Naïve Bayes method

Data analysis in the Naive Bayes Algorithm is based on probability and statistics to predict the class data based on previous experiences. In this analysis, the Naive Bayes algorithm was used to predict student graduation based on students' academic data. The data used in this analysis are data on UN students consisting of academic scores for mathematics, Indonesian, English, science, and average scores from each subject. Based on figure 5, the results of the analysis of Naive Bayes' student predictions built with training data using the Naïve Bayes algorithm explain that if the average score is $\leq$ 72.5, then the student is predicted not to pass, and if it is $\geq$ 72.5, then the student is predicted to pass. The results of the probability value obtained from the Nomogram are 81% and the error value is 19%

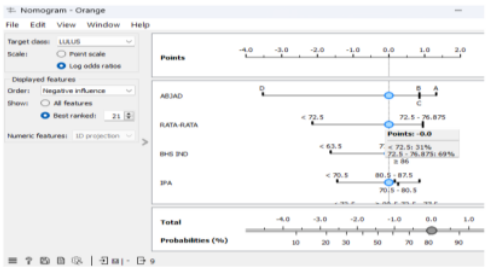

Figure 5. Prediction Analysis with Naïve Bayes' Algorithm

Figure 6 shows the nomogram used to predict the probability of student graduation based on average scores. The results of the analysis using the Naïve Bayes algorithm based on the training data that have been built are predicted to have an accuracy level of 63.64% and an error value of 36%, which shows that the prediction of class IXA students who will graduate in 2024 is seven students, and one student is predicted not to pass. In the above graph, the red color indicates that students have the potential to not pass the grades in the attributes. On the other hand, blue indicates that students are predicted to have the potential to pass the average score in attributes. Thus, the Naive Bayes algorithm can predict student graduation with a relatively high level of accuracy. However, it is important to note that this level of accuracy can vary depending on the quality of the data and complexity of the problem.

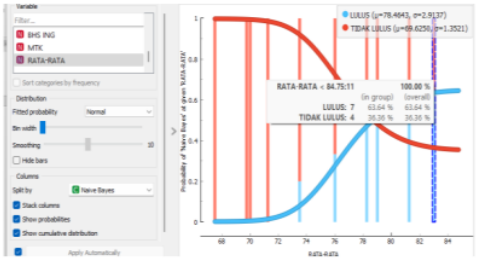

Figure 6. Prediction Analysis Based on Means on the Naïve Bayes Method

3.3 Prediction Results

The results of student graduation predictions using the decision tree and Naïve Bayes obtained different accuracies from the two methods. The prediction results are listed in Table 1.

Table 1 . Comparison of Algorithm Accuracy Results

Number	Method	Number of Passes	Number of Non-Graduates	Accuracy Values	Error value
1	Decision tree	10	1	90.91%	9.09%
2	Naïve bayes	7	4	63.64%	36.36%

Based on Table 3. shows that decision trees have high accuracy compared to Naïve Bayes, and the accuracy is the degree of proximity between the predicted value and the actual value. In this study, the performance of the decision tree has a higher accuracy of 90.91%, and Naïve Bayes has an accuracy of 63.64% based on the available data. However, both methods were used to predict student graduation in the visualization of the results, which can be helpful in understanding the process of predicting student graduation.

4. CONCLUSION

This study shows that the Decision Tree C4.5 algorithm is superior in predicting student graduation at YPK Immanuel Nabire Junior High School, with an accuracy of 90.91%, compared to the Naive Bayes algorithm, which has an accuracy of 63.64%. Both algorithms are used to help schools identify students who need special attention and to improve the efficiency of the graduation prediction process. The implementation of this algorithm uses the Orange software, which makes it easier to visualize and analyze data. The results of this study recommend the use of the C4.5 Decision Tree algorithm because it provides higher prediction accuracy, which can support the development of more effective and efficient learning programs in schools.

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