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# **The Innovation Breakthrough in Digital and Disruptive Era**

# Early Prediction for Graduation of Private High School Students with Machine Learning Approach

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**Abstract.** Graduation rates indicate school success. Predicting student graduation helps schools identify students in danger of dropping out and intervene early to enhance academic performance. It can also assist policymakers create graduation and dropout prevention initiatives. However, based on a literature search, predicting student graduation rates from admission test scores is difficult. School grades are a better predictor of timely tertiary graduation than acceptance test scores because college success requires cognitive abilities and self-regulation competencies, which are better indexed by school grades. Self-efficacy, school academic culture, and future expectations can also affect student graduation rates. Finally, the selective admissions modality needs to be refined. This study aims to (1) predict private high school graduation with eight algorithms: Random tree, Naïve Bayes Multinomial, Support Vector Machine (SVM), Random forest (RF), K-Nearest Neighbor, Ada Boost, Multilayer perceptron, Logistic regression, and (2) compare the performance of the eight algorithms. According to research, the Random tree, Naïve Bayes Multinomial, Random forest (RF), and Ada boost algorithms all perform at 99.49% for the first aim. For the second objective, the Random Tree approach outperforms other algorithms in Accuracy (99.49%), Precision (100%), F-Measure (99.74%), and consumption time (0 seconds). Therefore, the Random tree algorithm outperforms others. This research contributes in two ways: scientifically by testing eight algorithms—Random tree, Naïve Bayes Multinomial, Support Vector Machine (SVM), Random forest (RF), K-Nearest Neighbor, Ada Boost, Multilayer perceptron, and Logistic regression—to predict private high school graduation, and secondly by recommending school administrators to develop a selective enrollment model.

**Keywords:** data mining, student prediction, private high school, predictive analytics, predictive algorithm

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## 1 Introduction

Student graduation is an important indicator of school success performance[1]. The prediction of private high school student graduation refers to the use of data mining techniques and other research methods to predict student performance and high school graduation rates[2]. Predicting student performance and graduation rates is important for educational institutions to identify students who are at risk of dropping out of school and provide them with early intervention to improve their academic performance. In addition, student predictions can help institutions develop strategies to improve student performance and pass rates. The use of virtual learning environment data, machine learning algorithms, and educational data mining techniques have been applied to predict student success. A student graduation prediction system has been carried out using K-Nearest Neighbor[1], Naive Bayes[3], [4], Decision Tree C4.5[5], and comparing Naive Bayes and Decision Tree C4.5[5]. Identification of student behavior patterns using K-means clustering and support vector machines has also been used to predict student performance. Furthermore, studies on the relationship between the Big Five personality traits and academic achievement have been conducted to predict student performance. Therefore, the use of data mining techniques and other research methods can help educational institutions to predict student performance and develop strategies to increase student success.

It is important to research predicting student graduation for Private high school education because it can help educational institutions to identify students who are at risk of dropping out of school and provide them with early intervention to improve their academic achievement. The use of data mining techniques and other research methods can help educational institutions to predict student performance and develop strategies to increase student success. By predicting student graduation rates, educational institutions can assess institutional performance and student success[6]. In addition, research on predicting student graduation can help policymakers to develop policies and programs to increase high school graduation rates and reduce dropout rates.

However, there are several problems associated with predicting student graduation in private high school education. One of the main problems is the difficulty of accurately predicting pass rates using only acceptance test scores[2]. High school scores are a better predictor of on-time college graduation than admissions test scores because success in college requires not only cognitive abilities but also self-regulation competencies that are better indexed by high school scores[2]. Another issue is the challenge of creating a racially and ethnically diverse teaching force, which is primarily associated with increases in high school graduation, college enrollment, and college graduation rates of minority students[7]. In addition, several factors can affect student graduation rates, such as self-efficacy, school climate, and expectations for

the future[8]–[10]. Finally, there is a need to refine selective admissions models to determine which measure of prior achievement has the best predictive validity for academic success in universities[11].

Several research had been conducted before, like research for applying the Intelligent K-Medoids Algorithm to pre-processed data from 240 graduate students to predict student graduation time by Cahaya et al., (2017)[12]. The system forecasts graduation times by grouping students by 25 subject scores. 7 clusters having a silhouette value of 0.2416 are classified by graduation year. The method predicts 99.58% using k-cross with 5 subsets. Then Graduation Prediction Data Mining using Neural Networks STMIK students This study employs artificial neural network learning to predict student graduation on time using 2009 academic year data. A neural network with one input layer, one hidden layer, and one output layer accurately predicts on-time graduation. This data can boost graduation rates. This study uses three prediction models—SVM, GP, and DBM—to forecast graduation delays based on student performance by Ojha et al., (2017)[13]. The DBM outperforms the other models after being trained on student data. The Decision Tree Algorithm C4.5 by Purnamasari et al., (2019)[14] predicts student graduation rates with an accuracy of 69.79% and an error rate of 30.21. Factors Influencing Undergraduate Students' Intentions to Use Evidence-Based Practice After Graduation: Development and Validation of Theory-Based Prediction Models by Ramis et al., (2019)[15], then Student Graduation Time Prediction. This research uses a popular classification technique for A- and B-level learners to test the suggested two-level classification scheme. The algorithm's forecasts based on first-two-year course performance are accurate. RIPPER is the least accurate, followed by Naive Bayes and C4.5. Data mining to forecast student graduation timeliness by Wirawan et al., (2019)[16] examines three data mining methods and recommends the decision tree method for the highest accuracy. The decision tree method has 52.63% precision and 89.82% accuracy. The decision tree pullout is 41.67%. This study will help Syarif Hidayatullah UIN Jakarta supervise and monitor on-time graduates to preserve education quality.

Research on the Prediction of Student Graduation using the Naive Bayes Algorithm by Hartatik et al., (2020)[17] found that the algorithm can predict student academic progress. This model accurately predicts student achievement using IPS1,2,3,4, UN level, gender, and residence status. This methodology helps organizations and management forecast student progress and graduation. Research on Improving Classification Algorithms for Predicting Student Graduation followed. The Ensemble Model by Lagman et al., (2020)[18] demonstrated that combining the forecasts of many machine learning algorithms improves student graduation prediction accuracy. Combining Naïve Bayes models, Logistic Regression, Decision Trees, and Neural Networks improves results. Then Evaluation of the Backpropagation Neural Network Model for Early Prediction of Graduation of

XYZ University Students by Yaqin et al., (2021)[19] uses GPA scores to predict students' informatics study period at XYZ University. A network model with 50 neurons in the hidden layer, 0.01 learning rate, and 77% accuracy produced the best prediction results. MSE measures neural network model performance.

In Multivariate Sequential Modeling for Student Performance and Graduation Predictions by Kurniawati & Maulidevi, (2022)[20], both LSTM and GRU performed above 90% in predicting student performance and graduation. Both architectures perform better for different tasks. Graduation forecasts can improve first-semester performance, but recollection suffers. RMSE ratings can predict student achievement from the second semester. Separate strategies predicted student performance and graduation better than combined ones. Student Graduation Prediction Model The Deep Learning classification model using the CNN algorithm predicts student graduation with 87.44% accuracy by Salam et al., (2022)[21]. Good classification model evaluation. Training models with 80–100 layers are the most accurate. Then Prediction Accuracy Improvement This

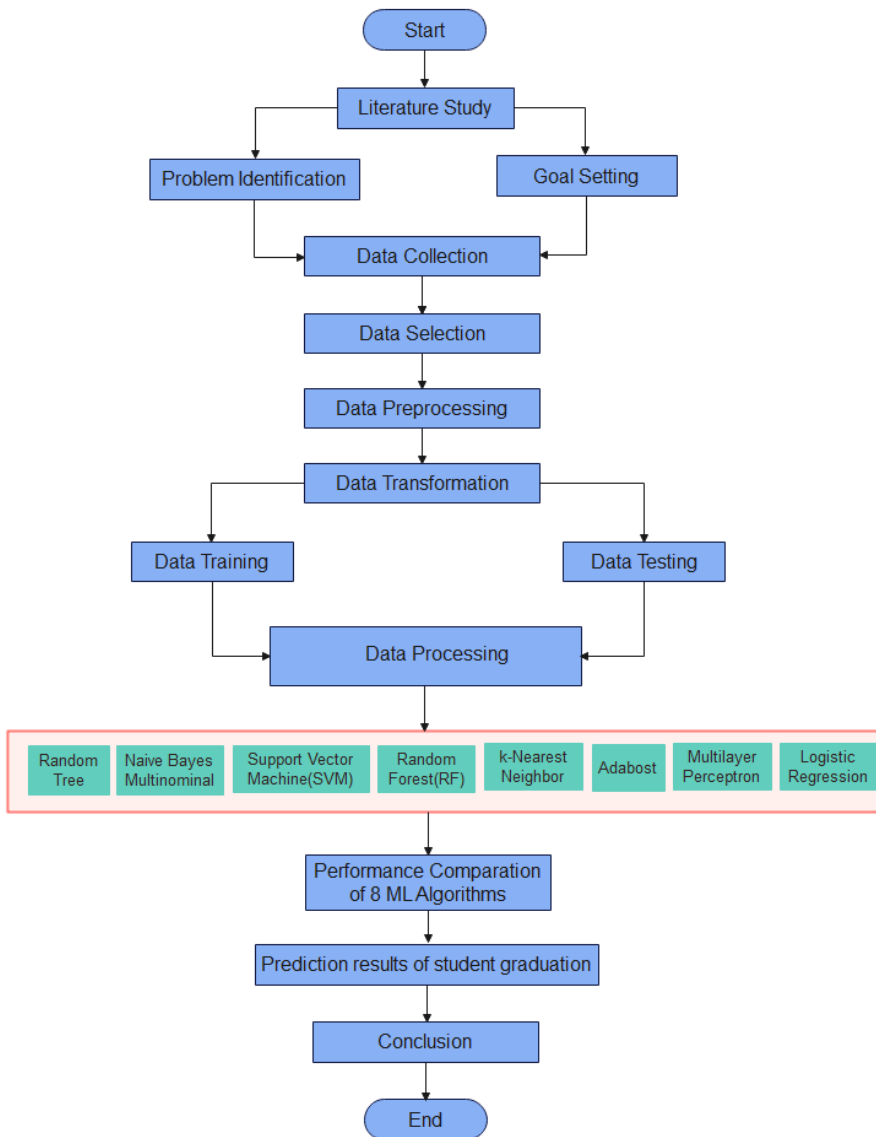
## 2 Research Methods

The stages of the Early Prediction for Graduation of Private High School Students with Machine Learning Approach research follow the steps as in the following flowchart in Figure 1 below:

research examines three prediction models (ANN, K-NN, and SVM) to forecast early graduation of XYZ University information systems and informatics students using SMOTE by Yaqin et al., (2022)[22]. This study employs SMOTE to address the class imbalance and reveals that ANN with a data imbalance of 62.5% to 70.5% has the best test accuracy score, followed by K-NN with 69.3% and SVM with 69.8%. ANN increased recall value to 71.3% the most.

This study aims to (1) predict private high school graduation with eight algorithms: Random tree, Naïve Bayes Multinomial, Support Vector Machine (SVM), Random forest (RF), K-Nearest Neighbor, Ada Boost, Multilayer perceptron, Logistic regression, and (2) compare the performance of the eight algorithms.

This study contributes in two ways: scientifically, by testing eight algorithms to predict private high school graduation (Random tree, Nave Bayes Multinomial, Support Vector Machine (SVM), Random forest (RF), K-Nearest Neighbor, Ada Boost, Multilayer perceptron, and Logistic Regression; and secondly, by recommending that school administrators develop a selective enrollment model.



**Fig. 1.** The steps of Research

**Table 1.** Explanation and details of the stages of the research

| No | Research Steps         | Explanation and details  |
|----|------------------------|--|
| 1  | Literature Study       | A literature study or literature review is carried out by studying research papers related to predicting student graduation through the Ministry of Education and Culture's Garuda portal journal database with keywords predicting student graduation and journal databases indexed in Scopus through the Publish or Perish (PoP) software. |
| 2  | Problem Identification | At this stage, it was carried out by observing the research carried out in 3 private high schools in Pamekasan Madura Regency, namely MAS. Matsaratul Huda Panempan Pamekasan, MAS. Miftahul   |

|   |              |  |
|---|--------------|--|
|   |              | Qulub Polagan Galis Pamekasan and MAS. Nurul Ulum Teja Barat Pamekasan. The time for the research was from January to March 2023. Based on observations, it was found that the problem identified was that there was no information on predicting student graduation at the Private Madrasah Aliyah.   |
| 3 | Goal Setting | At this stage, the research objectives were determined, namely (1) predicting student graduation using 8 (eight) algorithms, Random tree, Naïve Bayes Multinomial, Support Vector Machine (SVM), Random forest (RF), K-Nearest Neighbor, Ada Boost, Multilayer perceptron, and Logistic regression, (2) comparing the performance of the 8 (eight) algorithms for predicting graduation of |

|   |                     |  |
|---|---------------------|--|
|   |                     | Private Madrasah Aliyah students.  |
| 4 | Data Collection     | At this stage, it was carried out by studying secondary data recordings, interviews with parties related to this research, namely the Head of the Madrasah and the Head of Administration as well as collecting data on class XII grades of Private Madrasah Aliyah. The data examined in this study were 493 students.  |
| 5 | Data Selection      | In this data selection process by eliminating some attributes that are not relevant to the research objectives. The attributes that must be removed are Number, Student Name, Class, Gender, and Year Graduated. The selected attributes are only the final madrasah exam scores, practical exams, and attitudes because the information provided in them already represents the data needed to be used as research indicators. The final Madrasah exam scores, practice exams, and attitudes that were selected as input attributes in this study were the average results of all class XII subjects in their respective Madrasahs. |
| 6 | Data Preprocessing  | This stage aims to ensure that there is no duplication of data, identify inconsistent data, and correct errors in data, such as printing errors so that data can be processed. and used for data mining. In the process of cleaning this data, wrong data, duplicate data, and inconsistent data have been found, so the author is still cleaning the data so that good data is produced. The clean data consists of 4 (four) attributes, namely 3 (three) input data attributes including final Madrasah exams, practice and attitude exams, and 1 ( ) attribute as output which contains options about passing and not passing.    |
| 7 | Data Transformation | This data transformation stage is carried out by converting data into a format suitable for data mining processing. In this study, the Weka software wants the data to be processed in the form of ARFF to overcome compatibility. The data which was originally in the form of Microsoft Excel 2019 was transformed into the ARFF form so that it could adapt to the Weka software.   |

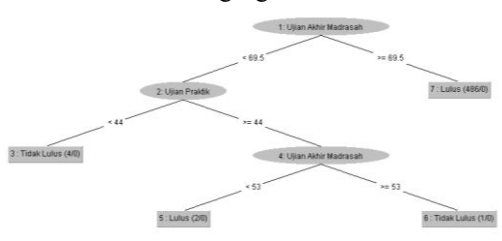
|    |   |  |
|----|---|--|
| 8  | Data Training & Testing                   | At this stage, the data is divided into training and testing data using WEKA software with a 20/80 data split  |
| 9  | Data Processing                           | At this stage, data processing is carried out using a percentage split of 20%. This means that data sharing will be 20% training data and 80% testing data. Of the 493 students, 99 people will get training data and 394 people testing data. Cleaned data will be processed using WEKA software.     |
| 10 | Performance Analysis of 8 ML Algorithms   | At this stage an analysis of student graduation predictions was carried out using 8 (eight) algorithms, namely Random tree, Naïve Bayes Multinomial, Support Vector Machine(SVM), Random forest(RF), K-Nearest Neighbor, Ada Boost, Multilayer perceptron and Logistic regression using WEKA software. |
| 11 | Performance Comparison of 8 ML Algorithms | At this stage, a comparison is made of the performance of the SVM and RF algorithms by calculating and comparing the values of Accuracy, Precision, Recall, F-Measure, Classification Error, and consumption time.   |
| 12 | Prediction results of student graduation  | At this stage the results of predicting student graduation are given with 8 (eight) algorithms namely Random tree, Naïve Bayes Multinomial, Support Vector Machine(SVM), Random forest(RF), K-Nearest Neighbor, Ada Boost, Multilayer perceptron, and Logistic regression.                             |
| 13 | Conclusion                                | Conclusions were drawn to answer research questions, namely the prediction of graduation of private Madrasah Aliyah students and to compare the performance of the 8 (eight) algorithms for the prediction of graduation of Private Madrasah Aliyah (MAS) students.                                    |

### 3 Results and Discussion

The results of the research on predicting graduation of Private High School students with 8 (eight) methods, namely the Random tree method, Naïve Bayes Multinomial, Support Vector Machine (SVM), Random forest (RF), K-Nearest Neighbor, Ada Boost, Multilayer perceptron, and Logistic regression. are as follows :

**A. Result of Processing Data**

The Random tree method produces a decision tree like the following figure:



**Fig. 2.** Random Tree Algorithm Decision Tree

From the decision tree in Figure 1 above it is explained that the root or node 1 is the attribute of the Madrasah Final Examination. This attribute resulted in 486 students who passed with a value  $\geq 69.5$ . What becomes node 2 is the practical exam resulting in 4 students who fail with a score  $< 44$ . In the

Madrasa Final Examination, 2 students passed but the score obtained was  $< 53$ , while 1 person did not pass with a score  $\geq 53$ .

**B. Performance Analysis of 8 ML Algorithms**

Comparing the performance of the Random tree, Naïve Bayes Multinomial, Support Vector Machine(SVM), Random forest(RF), K-Nearest Neighbor, Ada Boost, Multilayer perceptron, and Logistic regression algorithms to detect student learning styles is done using Weka tools. The performance of the algorithm is measured using five (5) parameters, namely (1) Accuracy, (2) Precision, (3) Recall/Sensitivity, (4) f-measure (5) classification error, and (6) Time Consumption. Based on the results of the calculation of the confusion matrix that has been done, the following results are obtained:



**Fig. 3.** Performance Comparison Graph of 8 ML Algorithms

The graph in Figure 3 above compares the performance of 8 (eight) algorithms namely Random tree, Naïve Bayes Multinomial, Support Vector Machine(SVM), Random forest(RF), K-Nearest Neighbor, Ada Boost, Multilayer perceptron, and Logistic regression. The first metric is accuracy, which measures the percentage of correctly classified instances of all instances. The table above shows that the eight algorithms have high accuracy. Random tree, Naïve Bayes Multinomial, Random forest

(RF), and Ada boost algorithms have the same highest performance or accuracy rate of 99.49%.

The second metric is precision, which measures the percentage of positive examples that are correctly classified out of all examples that are classified as positive. The Random tree and Ada boost algorithms have the same highest precision value of 100%. The third metric is Recall or sensitivity, which measures the percentage of positive examples that are

correctly classified out of all actual positive examples. The Naïve Bayes Multinomial algorithm has the highest recall value of 100%. The fourth metric is f-measure, which is a model evaluation metric that combines precision and recall to determine overall model performance. The Random tree, Naïve Bayes Multinomial, Random forest (RF), and Ada Boost algorithms also have the same highest f-measure value of 99, 74%.

The fifth metric is classification error, which is used to find out the percentage of data that is incorrectly classified by the model. Random forest (RF), Random tree, Naïve Bayes Multinomial, and Ada boost algorithms have a very small misclassification rate of 0.005 compared to other algorithms. The last metric is the time consumed by each algorithm to perform the classification task. Random tree and K-Nearest Neighbor, are much faster than the other algorithms, taking only 0 seconds compared to 0.27 seconds for the Multilayer perceptron which is the slowest to build the model. Overall, this table provides a clear and informative comparison of the performance of the nine algorithms, allowing the reader to quickly assess the strengths and weaknesses of the algorithms. Based on the table above, the error rate

## 4 Conclusions

This study aims at two (2) things, namely (1) to predict the graduation of private High School students with the Random Tree Algorithm, Naïve Bayes Multinomial, Support Vector Machine (SVM), Random forest (RF), K-Nearest Neighbor, Ada Boost, Multilayer Perceptron and Logistic Regression and (2) perform a performance comparison of the 8 (eight) algorithms for predicting Private High School student graduation. Based on the results of the research that has been done, it can be concluded that for the first objective.

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of each algorithm is obtained in predicting student graduation. This can be seen in the following graph:

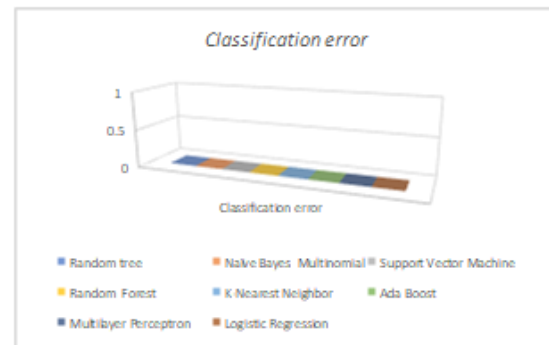


Fig. 4. Algorithm Error Rate Graph

The graph in Figure 4 above explains that the 8 (eight) algorithms namely Random tree, Naïve Bayes Multinomial, Support Vector Machine(SVM), Random forest(RF), K-Nearest Neighbor, Ada Boost, Multilayer perceptron and Logistic regression in this study have a very small misclassification rate, which is below 0.1. This means that the algorithm is feasible to use to predict student graduation in Private Aliyah Madrasas

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