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# Student Performance Prediction using Academic Performance and ML

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**Abstract :** *Predicting university student graduation is a beneficial tool for both students and institutions. With the help of this predictive capacity, students may make well-informed decisions about their academic and career paths, and institutions can proactively identify students who may not graduate and offer tailored support to ensure their success. The use of machine learning for predicting universit y student graduation has drawn more attention in recent years. Large datasets of student academic performance data can be used to train machine learning algorithms to identify patterns that are applicable in predicting future outcomes. In accordance with some studies, this approach predicts student graduation with an accuracy rate as high as 90%.*

**Keywords:** Artificial Intelligence, Machine learning, performance analysis, Fairness, Transparency, student record, performance prediction.

## I. INTRODUCTION

In higher education institutions, every institution has its student academic management system or record all student data containing information about student academic results in final examination marks and grades in different courses and programs. All student marks and grades have been recorded and used to generate a student academic performance report to evaluate the course achievement every semester. The data keep in the repository can be used to discover insightful information related to student academic performance.

Academic performance is the most important measure of the quality of college students, serving as the fundamental criterion for universities to monitor teaching quality and evaluate students' academic abilities in SVCET.

In school period, student's performance is reflected in both academic and practical performance. Academic performance refers to students' performance in various courses, while practical performance includes students' performance in research competitions and on-campus scholarships, among other aspects.

## II. LITERATURE REVIEW

### Student Academic Performance Analysis

Student academic performance is an important indicator of the effectiveness of the educational process. It is commonly evaluated using examination marks, internal assessment scores, attendance, grade point average (GPA), assignment marks, and semester results. Analysing these academic records helps educational institutions understand students' learning progress and identify those who may require additional academic support.

Traditional methods of performance analysis mainly depend on manual evaluation and statistical calculations. However, these methods may not

effectively identify complex patterns in large educational datasets. Machine learning provides an opportunity to analyse historical academic data and discover relationships between different student characteristics and their academic outcomes.

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**Machine Learning in Educational Data Mining**

Educational Data Mining (EDM) is an emerging research area that applies data mining and machine learning techniques to educational data. It focuses on extracting meaningful information from student records to improve teaching, learning, and academic decision-making.

Machine learning algorithms can be used to predict student grades, classify students according to their performance levels, identify students at risk of failure, and determine the factors influencing academic achievement.

According to Albreiki et al. (2021), machine learning and educational data mining have been widely investigated for student performance prediction, dropout identification, and the analysis of academic and learning-related data.

## III. PROPOSED METHODOLOGY

This paper aims to identify the most effective predictive model especially in addressing imbalanced multi-classification for student grade prediction. The framework consists of four main phases is shown in Figure 1. The input of our framework contains student's final course grade that we extract from student's academic spreadsheet document and student academic repository. We applied two data-level solution using oversampling SMOTE and two FS methods to reduce the overfitting and misclassification of imbalanced multi- classification dataset. Then, we design our proposed model by combining both techniques into selected machine learning classifier to evaluate the performance using performance metrics. Finally, data visualization is used to visualize the trend of dataset and final classification results. The description of each phases is given in the following subsection.

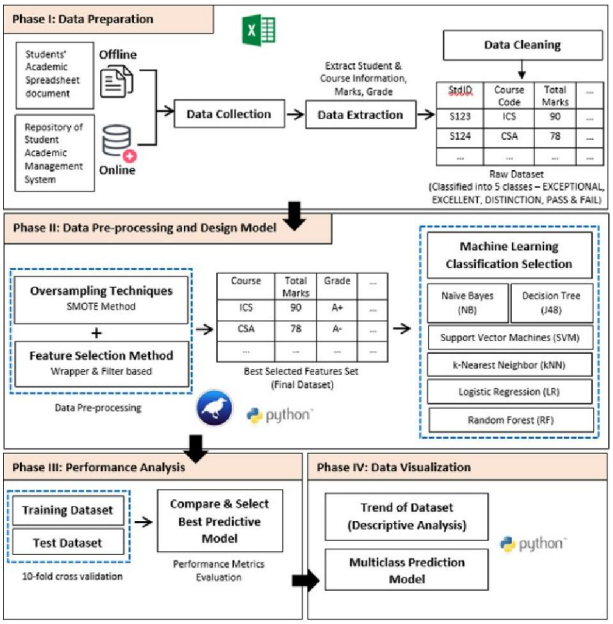



FIG 1. The framework of the proposed class prediction model for predicting final student grades.

## IV. ETHICAL PRINCIPLES AND CHALLENGES

The significance of highlighting the necessity to take into account legal and ethical considerations arises when addressing issues concerning compliance with the General Data Protection Regulation (GDPR), acquiring informed permission, safeguarding data privacy, and preserving data security

The significance of ethical considerations is of greatest significance, particularly in the implementation of AI and machine learning. It has been found that several studies have failed to adequately address concerns related to privacy and consent.

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The paper determining student academic performance is a crucial challenge in SVCET. Due to this, many previous researchers have well-defined the influence factors that can highly affect student academic performance. However, most common factors are relying on socioeconomic background, demographics and learning activities compared to final student grades in the final examination. As for this reason, we observe that the trend of predicting student grades can be one of the solutions that are applicable to improve student academic performance.

To address the challenge of clustering multiple discrete features accurately, we combine the proposed RMBN data processing approach with Louvain clustering. The experimental results demonstrate that this combination reduces the dimensionality of the encoded data, clarifies the connections between students and variables, and achieves highly modular grouping results.

## V. APPLICATIONS, RISKS AND EVALUATION

In the application of student performance prediction, most studies have employed machine learning algorithms. Yagci proposed a new model based on machine learning algorithms to predict undergraduates' final exam scores using midterm exam scores as the source data. The performance of the proposed model was compared with other machine learning algorithms, and the results showed a classification accuracy of 70%-75%. In terms of student dropout rates, Niyogisubizo et al. It used an ensemble model to predict students' dropout status in university courses.

The early identification of students who are at-risk of academic underperformance or dropping out enables educators and educational institutions to promptly intervene and provide the necessary support. The implementation of timely interventions has the potential to provide students with the essential resources and assistance required to enhance their academic achievements

## VI. CONCLUSION

In the developmental process of student learning, predicting student performance can help educators gain a greater understanding of students' learning needs. To delve into students' academic achievements across various subjects and their practical performance in diverse scenarios, we conduct a comprehensive analysis of student data with multiple dimensions. This paper's approach not only centers on understanding the overall learning patterns exhibited by the majority of students but also considers the performance of each student across distinct subjects and their practical aptitude in varying situations. Therefore, we propose a student performance prediction approach.

We apply the proposed model of student performance to real-world student data. The results demonstrate that our model is effectively predicting students' performance. By identifying students' performance, teachers can adjust their teaching strategies to cater to students' learning needs. By mastering the distribution of students' performance and future performance trends, educational administrators can deploy resources rationally to student groups with different performances.

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## APPENDIX

| Feature Name | Type | Description / Scale | Preprocessing & Encoding |
|---|---|---|---|
| prev gpa | Continuous | Cumulative GPA prior to target term (0.0–4.0 or 0–100) | Median imputation; Min-Max / Standard scaling |
| midterm score | Continuous | Mid-semester / internal assessment score (0–100) | Normalized to [0, 1] |
| assignment avg | Continuous | Mean score across graded coursework/labs (0–100) | Normalized to [0, 1] |
| attendance rate | Continuous | Percentage of classes/lectures attended (0.0–100.0%) | Mean/median imputation; normalized to [0, 1] |
| past failures | Discrete | Count of prior failed courses/modules (0, 1, 2, ...) | Integer / ordinal scaling |
| target_class (or final_score) | Target | e.g., At-Risk / Pass / Distinction or final exam score (0–100) | Label encoding (classification) or raw/scaled target (regression) |

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