

1. Introduction

With the increasing reliance on data-driven decision-making in education, machine learning (ML) has emerged as a powerful tool for predicting student performance. This study presents an intelligent system that leverages ML algorithms to classify students based on their academic success, providing actionable insights to educators and policymakers. The research focuses on three supervised ML techniques to identify the most accurate and efficient predictive model.

2. Methodology

2.1 Machine Learning Models Used

Three ML algorithms were implemented and evaluated:

- **Extra Trees** – Achieved the highest accuracy (98.15%) due to its ability to capture complex relationships in data.
- **Random Forest** – Performed well with an accuracy of 94.03%, benefiting from its ensemble learning approach.
- **K-Nearest Neighbors (KNN)** – Delivered an accuracy of 91.65%, effective for pattern recognition but less robust compared to ensemble models.

2.2 Dataset and Features

The dataset used in this study included student records with attributes such as:

- **Academic performance indicators:** Previous grades, attendance, participation.
- **Demographic factors:** Age, socioeconomic background, parental education.
- **Behavioral attributes:** Study habits, extracurricular activities, online engagement.

3. Results and Analysis

- The **Extra Trees algorithm outperformed** the other models, demonstrating superior feature selection and predictive capability.
- **Random Forest provided reliable results**, leveraging multiple decision trees to mitigate overfitting.
- **KNN showed lower accuracy**, likely due to sensitivity to high-dimensional data.
- **Key influencing factors** included student engagement levels, attendance rates, and past academic performance.

4. Conclusion and Future Work

The findings underscore the potential of ML-driven student performance prediction systems in shaping adaptive learning environments. Future research could explore deep learning techniques, real-time data integration, and personalized intervention strategies to further enhance predictive accuracy and educational outcomes.

5. References

Mustafa S. Ibrahim Alsumaidaie, Ahmed Adil Nafea, Abdulrahman Abbas Mukhlif, Ruqaiya D. Jalal, and Mohammed M. AL-Ani. "Intelligent System for Student Performance Prediction Using Machine Learning." *Baghdad Science Journal*, Vol. 21, Issue 12, Dec. 2024 (Online First: May 2024).