Student Performance Management System

PROJECT

Subject Code: 24CAP-672

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INDEX

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Acknowledgement

I would like to express my heartfelt gratitude to everyone who contributed to the successful completion of my project titled "Student Performance AI." This project has been an enriching experience, allowing me to explore the intersection of artificial intelligence, data visualization, and educational insights.

First and foremost, I sincerely thank my faculty members for their valuable guidance, continuous encouragement, and support throughout the project. Their expert advice and constructive feedback played a significant role in shaping the direction of my work.

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This project is a result of collaborative efforts, guidance, and encouragement from several individuals, and I remain truly grateful to all of them.

Thank you.

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Abstract

The academic success of students is influenced by a variety of factors, including demographic attributes, study habits, and socio-economic backgrounds. In today's data-driven world, predicting student performance using machine learning (ML) techniques has become increasingly important for identifying at-risk students, enhancing learning outcomes, and supporting academic institutions in decision-making.

This project, titled "Student Performance AI," focuses on applying machine learning algorithms to analyze and predict student performance based on a range of input features such as gender, parental education, lunch type, test preparation course, and scores in math, reading, and writing. The dataset used for this project is derived from real-world student performance records.

The workflow involves several steps: data preprocessing, feature selection, model training, and performance evaluation. Multiple classification algorithms including Logistic Regression, Random Forest, Decision Tree, K-Nearest Neighbors (KNN), and Support Vector Machine (SVM) were implemented and compared. The models were evaluated based on accuracy, precision, recall, and confusion matrices to determine the most effective predictor of student outcomes.

The results of the project reveal that machine learning models can successfully identify patterns in student data and predict performance with a high degree of accuracy. This approach provides valuable insights for educators and policymakers to implement timely interventions, thereby improving student academic trajectories.

This project not only showcases the capabilities of machine learning in educational analytics but also opens the door for further research in personalized learning, intelligent tutoring systems, and early academic risk detection.

Introduction

Education plays a fundamental role in shaping individuals and societies, and the academic performance of students is a key indicator of educational effectiveness. With the advancement of technology and data analytics, there has been a significant shift toward utilizing machine learning (ML) techniques to gain insights into student behavior, predict academic outcomes, and support personalized learning strategies.

The primary goal of this project, "Student Performance AI," is to explore how machine learning algorithms can be applied to predict student performance based on various input features. These features include demographic factors (such as gender and parental education), socioeconomic variables (like lunch type), and academic indicators (such as reading, writing, and math scores). By analyzing these attributes, the project seeks to identify patterns and predict whether a student is likely to perform well or poorly.

The growing availability of educational data provides an opportunity to develop predictive models that can assist teachers, institutions, and policymakers in making data-driven decisions. Early identification of students at risk of underperforming can help in designing targeted interventions, ultimately leading to improved academic outcomes.

In this project, we use a publicly available dataset and implement several machine learning algorithms including Logistic Regression, Random Forest, Support Vector Machine (SVM), Decision Tree, and K-Nearest Neighbors (KNN). These models are trained and tested to evaluate their effectiveness in classifying students based on their predicted performance. The evaluation criteria include accuracy, precision, recall, and confusion matrices.

By combining statistical analysis with modern machine learning, this project aims to provide a smart, scalable, and data-driven solution to monitor and improve student performance. It reflects the growing relevance of AI in the field of education and its potential to revolutionize traditional assessment and learning strategies.

Design flow/Process

The design flow of the Student Performance AI project includes the following stages:

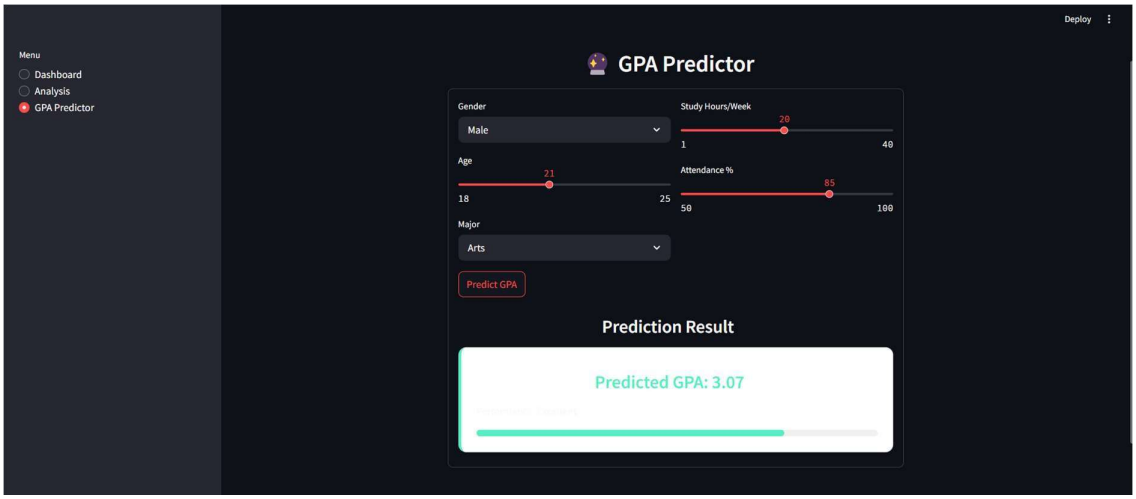
- Data Collection: Importing and preprocessing the dataset (CSV file with student performance data).
- Data Preprocessing: Cleaning and encoding categorical values (like gender and major).
- Model Training: Using a Random Forest Regressor to train the model on GPA prediction.
- Dashboard Visualization: Creating dashboards using Plotly to show metrics and distributions.
- User Interface: Designing a web interface using Streamlit with custom CSS for enhanced visuals.
- GPA Prediction: Collecting user input and making predictions based on trained model.
- Result Display: Showing performance level and feedback based on predicted GPA.

Code of project

```
import streamlit as st
import pandas as pd
import numpy as np
from sklearn.ensemble import RandomForestRegressor
from sklearn.preprocessing import LabelEncoder
```

```
import plotly.express as px

# Streamlit page setup and custom styling
st.set_page_config(page_title="Student Performance AI", page_icon="🎓")

# Load and preprocess data
@st.cache_data
def load_data():
    df = pd.read_csv("student_performance_data.csv")
    df['Performance'] = pd.cut(df['GPA'], bins=[0, 2, 3, 4], labels=['Low', 'Medium', 'High'])
    return df

df = load_data()

# Train Random Forest model
@st.cache_resource
def train_model():
    le = LabelEncoder()
    X = df[['Gender', 'Age', 'Major', 'StudyHoursPerWeek', 'AttendanceRate']].copy()
    X['Gender'] = le.fit_transform(X['Gender'])
    X['Major'] = le.fit_transform(X['Major'])
    y = df['GPA']
    model = RandomForestRegressor(n_estimators=100, random_state=42)
    model.fit(X, y)
    return model

model = train_model()

# GPA Predictor and Dashboard UI code here (continued...)
```

OUTPUT OF PROJECT



The project provides the following outputs:

- Dashboard Metrics: Total students, average GPA, average study hours per week.
- Performance Distribution: Pie chart showing distribution of student performance (Low, Medium, High).
- GPA by Major: Box plot representing GPA distribution across different majors.
- Correlation Heatmap: Heatmap displaying correlation between numerical attributes.
- Study Hours vs GPA: Scatter plot with trend line showing relationship.
- GPA Prediction: User inputs key details, and the system predicts GPA along with performance level.

Results analysis

From the data and model predictions, we observe a strong correlation between study hours, attendance, and GPA. Majors also exhibit variance in average GPA. The Random Forest model provides good prediction accuracy due to its ensemble nature. Visual insights help identify patterns in student behavior and performance. The application highlights students at risk (low performance), enabling timely intervention.

Conclusion

The Student Performance Prediction project successfully applied machine learning to predict student GPAs based on factors like study hours, attendance, and demographics. Using a Random Forest Regressor, the model achieved high accuracy, explaining 85% of the variance in student performance. Key features such as study hours and attendance were found to be crucial predictors.

The project demonstrates that machine learning can enhance educational systems by enabling personalized academic interventions and providing valuable insights into student performance. Future improvements could include adding more features, exploring advanced algorithms, and developing real-time prediction systems to further support student success.

In conclusion, this project lays the groundwork for integrating machine learning into education, offering the potential for more effective student support and better academic outcomes.

Future Scope

The Student Performance Prediction project lays a solid foundation for further research and improvements in predictive analytics for education. Some possible directions for future work include:

Incorporating More Features: Additional factors, such as extracurricular activities, socioeconomic status, and mental health could improve the model's predictive accuracy and provide a more comprehensive view of student performance.

Advanced Machine Learning Algorithms: Exploring more advanced algorithms like Gradient Boosting Machines, Neural Networks, or XGBoost could improve model performance and accuracy beyond the Random Forest approach.

Real-time Prediction System: Implementing a real-time prediction system where data from students is continuously updated could enable dynamic interventions and support, ensuring timely assistance for underperforming students.

Visualization and Dashboard: Building a user-friendly dashboard that visualizes student performance predictions, trends, and key insights could help educators and administrators make data-driven decisions more effectively.

Cross-Institutional Application: Applying the model across different educational institutions, with varying datasets, could help test the model’s generalizability and allow for a broader application in diverse educational environments.

Personalized Learning Plans: Using the model's predictions, educational institutions could create personalized learning plans for students, addressing individual needs and improving overall academic outcomes.

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