SmartLearn – A Personalized Learning Platform Based on Machine Learning

# Introduction

In traditional education systems, standardized teaching approaches fail to address the unique learning needs of individual students. The emergence of Artificial Intelligence (AI) and Machine Learning (ML) offers new opportunities to adapt educational content dynamically based on learners' performance. This project introduces SmartLearn, a personalized learning platform that leverages ML to guide students through individualized learning pathways while providing teachers with tools for monitoring, analysis, and recommendation. The main objective is to enhance educational outcomes by recommending the most appropriate content and support mechanisms based on student performance data.

# Methods

1. **Data Collection**  
   The public dataset "Students Performance in Exams" (from Kaggle) was used. The dataset includes 1,000 entries and contains the following key fields:  
   - math\_score, reading\_score, and writing\_score.  
     
   **2. Data Preprocessing**  
   - The three score columns were cleaned and normalized using the StandardScaler method from Scikit-learn.  
   - An average score was calculated for each student.

**-Caractéristiques principales** :

* 1. Notes en mathématiques, lecture et écriture
  2. Informations démographiques (genre, niveau d'éducation des parents, etc.)  
     - A new categorical variable parcours\_id was created to classify student performance:  
      - 0 = Low level (average < 60)  
      - 1 = Medium level (average between 60 and 80)  
      - 2 = High level (average > 80)
  3. **3. Machine Learning Model**  
     - The K-Nearest Neighbors (KNN) algorithm was used to predict the optimal learning path (parcours\_id) for a new student based on their scores.  
     - The model was trained on the normalized dataset.  
     - The model predicts the most suitable performance group for a new user input.

**Performance du modèle** :

1-Précision : 89 % (validation croisée à 10 folds

2-Séparation claire entre les groupes de performance  
  
**4. User Interface – Streamlit Application**- Student Interface:  
 - Simple form for score entry.  
 - Display of a personalized recommendation based on the predicted learning path.  
- Teacher Interface:  
 - Overview of all students with scores and averages.  
 - Filtering by performance level (low/medium/high).  
 - Export of results in Excel format.  
  
**5**. Technologies Used  
- Python  
- Streamlit (for web interface)  
- Pandas, Scikit-learn (for data handling and ML)  
- Matplotlib (for statistics visualization)

# Results

The platform is now operational and supports two main user roles: students and teachers.  
- Student interface successfully provides immediate, tailored learning path recommendations based on input scores.  
- Teacher interface allows effective monitoring of student performance, with filtering and export functionalities.  
- The KNN model achieves high accuracy in predicting the appropriate learning path class (parcours\_id) with clear separability across the three groups.  
- Visualizations such as pie charts help educators gain a holistic view of student distributions and adapt teaching strategies accordingly.

# Discussion

The SmartLearn prototype demonstrates the feasibility and value of using ML for personalized education. Even with a relatively small and structured dataset, meaningful performance segmentation and content recommendation were achieved. The project showcases how technology can support differentiated instruction and facilitate the work of educators.  
  
Challenges included:  
- Limiting user management (authentication is basic).  
- Static content recommendations due to the absence of a real-time content database.  
  
Future work includes:  
- Full integration with a user management system and real-time database (e.g., MySQL, Firebase).  
- Addition of level-appropriate multimedia learning content (videos, exercises, documents).  
- Application of the system to real student data from schools or universities.  
- Enhancement of the recommendation engine with hybrid or deep learning models.

# Conclusion

The SmartLearn platform confirms that AI-powered personalized education is achievable through thoughtful data use and accessible technologies. The current prototype is a solid foundation for building a scalable, intelligent educational system that supports both learners and educators by tailoring learning to individual needs and providing data-driven feedback. This project provides a clear proof-of-concept for future development toward a complete adaptive learning ecosystem.