INFORMATICS INSTITUTE OF TECHNOLOGY

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GradeGenius

Personalized Adaptive Learning Management System with Content Recommendation and Students' Grade Prediction

A Dissertation by

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Abstract

In today's educational landscape, identifying at-risk students and providing personalized, adaptive learning experiences remain critical challenges. Traditional Learning Management Systems (LMS) lack dynamic tools for predicting student performance, adapting learning pathways, and recommending content based on individual needs. This project addresses these gaps by developing an LMS that utilizes advanced AI techniques to enhance grade prediction, personalize content recommendations, and support early interventions for at-risk students.

A hybrid approach combining a Transformer-based LSTM autoencoder and Explainable AI (XAI) techniques was implemented. The autoencoder leverages multi-head self-attention and positional encoding to capture temporal learning behaviour patterns, and it employs anomaly detection via reconstruction error to identify at-risk students. The inclusion of XAI further enhances transparency by elucidating the model's prediction rationale, thereby aiding educators in understanding which features contributed to a student's risk status. Comprehensive data preprocessing, feature selection, and hyperparameter tuning supported by cross-validation and ablation studies optimized the model's accuracy and adaptability.

In parallel, a dual-path neural network merges student and content metadata through element-wise feature interactions to generate real-time, adaptive recommendations. SHAP-based XAI highlights key drivers behind suggestions, fostering trust. This module supports proactive guidance by tailoring resources to individual needs, enhancing the system's capacity for personalized academic support.

Early testing showed promising results, with an accuracy rate of 85% and an AUC-ROC of 0.92. The LSTM-based grade prediction model effectively identified at-risk students, achieving a balanced F1 score of 0.85. These results suggest the system's potential to enhance student success through timely, personalized learning interventions.

Subject Descriptors: Information systems -> Personalization -> Adaptive learning systems; Computing methodologies -> Artificial intelligence -> Machine learning -> Neural networks.

Keywords: Student performance prediction, adaptive learning, content recommendation, deep learning, Explainable AI.