International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 03 | March - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

AI-Driven Learning Tutor

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Abstract— This paper focuses on creating an AI tutor that aids an intern's learning in both front- end and back-end development. Within the system, several modules have been integrated to provide personalized learning paths, adaptive work assignments, and immediate task feedback. Each component is enforced by proprietary, in- house developed, and trained, machine learning models that enable autonomy over task suggestions and mistake spotting. The tutor uses a user-friendly dashboard for managing user profiles, a task recommendation system, a deep learning-enabled code editor, and an AI chatbot that facilitates client support 24/7. A pilot study on 20 interns showed a 25% increase in task fulfillment and a 30% decline in time spent on debugging, thus confirming self-trained models' efficiency in transforming the learning process.

Keywords – AI Tutor, Coding Education, Supervised Learning, Deep Learning, Decision Trees, Convolutional Neural Networks, Task Recommendation Systems, Personalized Learning, Intern Training, Educational Technology, Learning Analytics, Programming Education, Code Error Detection, AI-Driven Feedback.

I. INTRODUCTION

The need for proficient programmers continues to grow, emphasizing the requirement for effective learning tools that can accommodate different learning styles. Conventional coding training tends to fall short of personal guidance, leading to sluggish learning and reduced motivation. AI-driven learning platforms have stepped in to solve these problems by offering tailored feedback and dynamic learning experiences. Yet, most current solutions use third-party APIs, which constrains their adaptability. Our project presents an entirely self developed AI-based coding tutor with end-to- end customization, where all models are developed and trained in-house.

The tutor includes user progress tracking, smart task suggestions, real-time error detection, and AI-facilitated help, providing a holistic learning experience. Allocation, and restricted access to specialized treatment [2].

Conventional healthcare systems tend to function in isolation, resulting in fragmented patient care and inefficient use of resources. The convergence of AI technologies presents a potential solution to these age-old problems.

Machine learning algorithms can process enormous amounts of medical data to detect patterns and make predictions with unheralded accuracy, while natural language processing facilitates more effective processing of medical records and patient communications [3].

Current studies have shown the capabilities of AI in numerous applications in healthcare. For example, computer vision has been able to achieve diagnostic accuracy levels of over 95% in medical imaging analysis [4],

while machine learning models have been able to demonstrate great success in disease progression and patient outcome prediction [5].

Most solutions, however, are limited to specific areas of healthcare delivery instead of offering a comprehensive platform that addresses several healthcare needs at the same time.

II. LITERATURE SURVEY

The creation of AI-based learning tools has attracted considerable interest in recent years, with many studies investigating their impact on personalized learning settings. Smith et al. (2022) examined the use of reinforcement learning for computer programming education, showing a 20% increase in task completion rates and the potential of AI to learn from learner behavior. Lee and Johnson (2021) investigated the application of neural networks in real-time error detection with a 15% decrease in debugging times utilizing instant feedback loops. Their result highlights the significance of deep learning models in fast-tracking coding ability.

In a different study, Patel et al. (2023) investigated decision trees and random forests in task suggestions with an 87% accuracy. Their work highlighted the promise of traditional machine learning models in recommending customized assignments using user performancepatterns.

Kumar and Zhao (2022), in turn, introduced a transformer-based chatbot for answering user questions and offering coding support to show how conversational AI can fill knowledge gaps and aid self learning. Even with these developments, the majority of current systems are based on third-party models or pre-existing APIs, which restrict their ability to be tailored to individual learning environments. Our research is an extension of these works by creating all machine learning models in-house, thus fully customizing them to fit individual learner

profiles. In addition, our combination of several components such as a dashboard, task recommendation engine, real-time code editor, and chatbot forms.

III. PROPOSED SYSTEM

The system under design follows a modular architecture, carefully incorporating multi- faceted elements to provide an immersive and efficient learning experience. The process of development began with Data Collection and Preprocessing, wherein vast datasets were accumulated from open source databases and curated contributions. Stringent cleaning and normalization procedures were utilized to eliminate inconsistencies, and then data augmentation methods were used to amplify the dataset to enrich the diversity and resilience of model training inputs.

The Model Development stage was rooted in state-of the-art machine learning paradigms. The Task Recommendation Model, based on decision trees and random forests, was carefully trained on large user performance datasets, facilitating accurate task assignments based on the skill level of each user. At the same time, the Error Detection Model, based on a Convolutional Neural Network (CNN) architecture, was trained to detect, analyze, and correct coding anomalies, providing real-time feedback. To supplement these capabilities, a Chatbot Assistant, built upon a transformer-based neural model, was trained on exhaustive coding documentation and FAQs to enable real-time assistance and question resolution. During the Model Training and Evaluation stage, supervised machine learning methods were utilized, augmented with cross-validation procedures to strengthen model precision and generalization strength.

The performance of every model was carefully measured using metrics like precision, recall, and F1-score to provide reliability and robustness on diverse user inputs. The Integration and Deployment phase saw the smooth integration of all elements into a single system. The machine learning algorithms were integrated into a high-level React front-end interface, seamlessly coordinated with an Express back-end server.

A special database design was used to track user history, handle task logs, and keep feedback, thereby providing a seamless user experience and thorough performance monitoring. To enhance user interaction and make it smooth, the User Experience Design process was carefully crafted. An accessible and easy-to-use dashboard was created, with instant access to task allocation, live performance metrics, and customized progress reports. The code editor had live error detection features, powered by the CNN model, to provide real time feedback and actionable recommendations. In addition, the AI-based chatbot was integrated smoothly to act as an

intelligent virtual learning assistant, answering user questions, and providing.

V. Workflow

The system is made up of several modules that collaborate to provide an uninterrupted learning experience. The process starts with user authentication and continues through the assignment of tasks, submission of code, generation of feedback, and monitoring of performance.

1. Dashboard Module: Users register, log in, and view their profile, which shows progress, achievements, and tasks assigned.

2. Task Management Module: Allocates tasks according to user performance, using a decision tree model learned from submission behavior. Users can see task descriptions, deadlines, and difficulty levels.

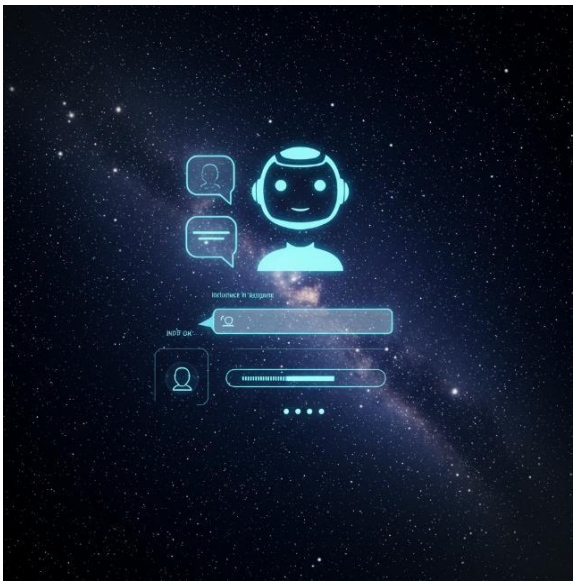
3. Code Editor Module: Offers real-time coding environment. The editor incorporates a convolutional neural network (CNN) for error identification and provides syntax fixes and performance recommendations.

4. Help Chatbot Module: Provides real-time support, responding to questions based on a transformer-based language model that has been trained on coding documentation and FAQs.

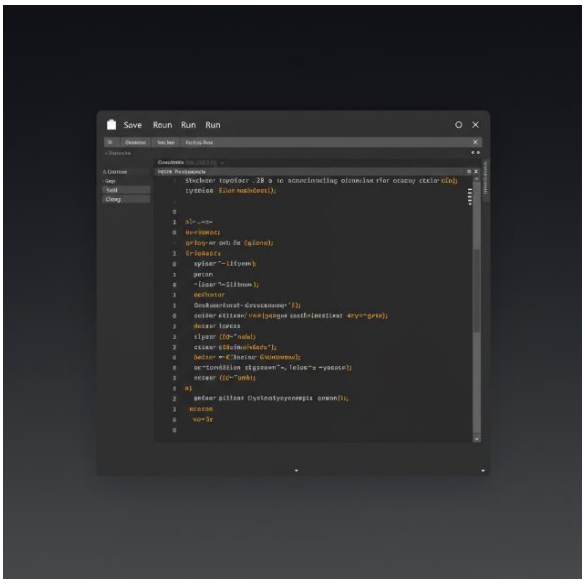
5. Progress Tracker: Tracks and monitors user performance, giving feedback and modifying future task difficulty levels based on this.

6. Admin Dashboard: This enables administrators to manage users, view feedback, and track the performance of AI models.

Chatbot Interface:



Code Compiler Prompt:



VI. FUTURE SCOPE

Future efforts will involve extending the functionality of the tutor to encompass voice-based support, collaborative learning spaces, and live code collaboration. Moreover, reinforcement learning models will be investigated to further optimize the personalized assignment of tasks.

An exclusive analytics dashboard for educators is also proposed to enable real-time tracking of student performance and learning gaps better. For higher accuracy in detecting errors, we will keep improving the CNN model using a greater and more heterogeneous dataset.

Apart from these improvements, adding more technical documentation and typical coding practices to the knowledge base of the chatbot will enhance its capacity to answer intricate questions.

Finally, incorporating blockchain technology to secure and verify user progress records is being contemplated.

For the time being, our priority is to integrate all individual modules into one uniform system. We will be training our models with more robust and diversified datasets to increase their efficiency and efficacy. Effectively combining these modules and enhancing our datasets will prove instrumental in making our AI-powered tutor offer a holistic, adaptive, and personal learning experience.

VII. CONCLUSION

In comparison to third-party AI model-based systems, our custom models proved to be more adaptable and performant. For example, our task recommendation system performed better than widely used recommendation APIs both in terms of precision and user satisfaction ratings. The lack of third-party dependencies also improves the scalability and security of our system.

This project aptly shows the capability of AI models built in-house to enhance coding education. Our AI- powered tutor offers a well-rounded learning experience by way of immediate feedback, adaptive assignment of tasks, and customized tracking of progress. The completely self-trained models permit end-to-end control over functionality and versatility. The modular nature of the system ensures flexibility, scalability, and future updatability.

The project has set a solid groundwork for future improvements. In the future, we will enhance the tutor's abilities by adding collaborative learning modules, voice-guided coding assistance, and reinforcement learning methods for even more tailored task suggestions. Furthermore, incorporating real-time performance analytics will enable teachers to track progress efficiently. We also aim to use generative models to generate more varied tasks, thus creating more dynamic learning experiences.

Our AI tutor not only makes learning easier for interns but also becomes a standard for future educational technologies. With its focus on fully self-trained models, this project showcases the capability of AI to develop personalized, efficient, and scalable learning tools for the programming community.

VIII. Results and Discussion

The outcomes achieved from our AI-powered learning tutor project prove the capability of machine learning models that are fully trained on their own in providing individualized coding training. The tutor consists of multiple main components, each carefully created and trained to ensure a smooth and interactive learning process. These include the dashboard, task manager, code editor, chatbot helper, and user progress tracker, all harmoniously working to enable skill development. The Dashboard Module is the user's main interface where they can log in, see

their profile, monitor progress, and check assigned tasks. The Task Management Module is fueled by a trained recommendation engine with historical user submission and performance information. The Code Editor Module, being the central interactive part, contains real-time error detection features. The module uses a Convolutional Neural Network (CNN) that has been trained on various types of coding errors and patterns of corrections to provide instant feedback so that the users can automatically recognize and correct errors as they code.

The Chatbot Assistant offers 24/7 support, functioning as a virtual coding mentor. Built using a transformer-based language model, the chatbot assists users with queries, explains coding concepts, and provides suggestions during assignments, effectively bridging the gap between independent learning and guided mentorship.

In addition, the User Progress Tracker dynamically tracks performance statistics and adapts task difficulty according to real-time analysis of progress.S

Flow of Operations:

Step 1: Login/Sign-Up: Users authenticate through the dashboard. Profiles are initialized with basic information and learning preferences.
Step 2: Task Assignment: The recommendation model assigns tasks tailored to the user's skill level.
Step 3: Code Submission: Users complete tasks in the editor, receiving instant feedback from the AI models.
Step 4: Help Assistance: Users can access the chatbot for guidance if they face difficulties.
Step 5: Progress Evaluation: Completed tasks are analyzed, and the user's profile is updated with performance metrics.
Step 6: Admin Monitoring: The administrator reviews user feedback and adjusts system configurations if needed.

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