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STACKED-ML: Full-Stack Application for ML Learning and Practice

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Abstract: The rise of digital learning has paved the way for interactive platforms that facilitate knowledge acquisition in an engaging and structured manner. The Stacked-ML Interactive Platform is designed to provide a comprehensive learning experience for individuals looking to enhance their skills in Machine Learning (ML) and programming. By leveraging a problem-based learning approach, the platform offers daily challenges, real-time code execution, and personalized progress tracking. This study examines the core features of the platform, including problem categorization, an integrated Python code editor, and user engagement strategies. Additionally, we discuss the technical implementation, key challenges, and potential enhancements that can further optimize the user experience. The Stacked-ML Interactive Platform serves as an innovative tool for learners of varying expertise levels, ensuring continuous skill development through practical application and interactive problem-solving.

Index Terms - Machine Learning, Programming, Interactive Learning, Problem-Based Learning, Code Execution, Educational Platform, Online Learning, Python, User Engagement

I. INTRODUCTION

With the increasing demand for ML and programming skills, there is a need for effective learning environments that blend theory with practical application. Traditional educational resources such as textbooks and pre-recorded lectures often fail to provide the hands-on experience necessary for

mastering these subjects. Online courses and tutorials attempt to fill this gap, but they may lack interactive engagement and personalized feedback.

The Stacked-ML Interactive Platform seeks to bridge this divide by offering a dynamic, problem-based learning experience where users can actively apply their knowledge to solve real-world problems. By integrating structured problem sets, daily challenges, and an interactive coding environment, the platform ensures that users not only learn theoretical concepts but also develop practical coding skills.Additionally, the platform caters to learners of different skill levels by categorizing problems into various difficulty levels. This structured progression enables beginners to build a strong foundation while allowing more advanced users to tackle complex challenges. Real-time code execution and output visualization provide immediate feedback, helping users to debug and refine their solutions efficiently.

Through these features, the Stacked-ML Interactive Platform fosters a learning ecosystem that is engaging, efficient, and accessible to a wide audience. Whether a novice trying to grasp basic programming concepts or an experienced individual looking to sharpen ML skills, the platform provides valuable learning opportunities tailored to each user's needs.

Despite the abundance of online learning resources, many learners struggle to transition from theoretical knowledge to practical application. Traditional learning methods often lack interactivity, immediate feedback, and structured progression, making it difficult for learners to develop problem-solving skills. Additionally, there is a gap in platforms that offer categorized, hands-on challenges specifically designed for ML and programming education. The absence of a structured, real-time coding environment leads to a steep learning curve, reducing user engagement and retention.

The Stacked-ML Interactive Platform addresses these challenges by integrating problem-based learning with real-time execution capabilities, providing learners with a hands-on coding experience tailored to different skill levels.

The primary objective of the Stacked-ML Interactive Platform is to provide an engaging and interactive learning experience for individuals interested in Machine Learning and programming. The platform is designed to:

· Offer a structured problem-solving approach to facilitate hands-on learning.

· Provide a real-time coding environment with instant feedback and error handling.

· Categorize problems into different difficulty levels to accommodate beginners and advanced learners.

· Encourage user engagement through daily challenges and progress tracking features.

· Enable users to contribute and explore problems across multiple categories.

· Enhance skill development through a well-organized, interactive learning experience.

By achieving these objectives, the platform aims to bridge the gap between theoretical knowledge and practical implementation, ensuring a more effective and enjoyable learning journey for users.

2.LITERATURE SURVEY

The field of interactive learning has evolved significantly with the integration of technology, fostering new methodologies in teaching and knowledge acquisition. Various studies emphasize the importance of **problem-based learning (PBL)**, **adaptive learning environments**, and **real-time feedback systems** in enhancing learner engagement and improving learning outcomes.

2.1 Problem-Based Learning (PBL) in Online Education

Problem-based learning (PBL) has been widely recognized as an effective approach for fostering critical thinking and problem-solving skills in learners. According to **Barrows (1986)**, PBL encourages students to engage in self-directed learning by tackling real-world problems, thereby bridging the gap between theoretical knowledge and practical application. Studies by **Schmidt et al. (2011)** further highlight that students who engage in PBL show better knowledge retention and higher problem-solving capabilities compared to those who follow traditional lecture-based learning models.

In the context of coding education, platforms such as **LeetCode, CodeSignal, and HackerRank** have successfully implemented PBL to allow learners to actively engage with coding problems. The Stacked-ML Interactive Platform builds upon this foundation by incorporating **structured problem-solving with an ML-driven adaptive learning mechanism** to enhance user experience and learning effectiveness.

2.2 Adaptive Learning Systems in Online Platforms

Adaptive learning leverages artificial intelligence (AI) to tailor educational content to a learner's needs. Research by **Brusilovsky & Millán (2007)** highlights the role of adaptive learning in **personalizing user experiences**, ensuring that learners receive recommendations based on their progress and performance. Platforms like **Coursera and Udacity** utilize adaptive learning models to suggest relevant courses, assignments, and learning paths based on learner interaction data.

The Stacked-ML Interactive Platform integrates adaptive learning by tracking user progress and recommending challenges that match their skill level. By analyzing users' submission history and problem-solving patterns, the platform dynamically adjusts the difficulty level of problems, helping learners develop skills at an optimal pace without feeling overwhelmed.

2.3 Role of Real-Time Feedback in Learning

Real-time feedback plays a crucial role in accelerating the learning process. Research by **Van der Kleij et al. (2011)** emphasizes that instant feedback reduces cognitive load and helps learners correct mistakes more efficiently. The study further suggests that platforms incorporating real-time feedback significantly improve engagement and long-term retention of concepts.

Online learning platforms such as **Codecademy and DataCamp** have successfully utilized real-time feedback mechanisms to assist learners in debugging and refining their solutions. The Stacked-ML Interactive Platform follows a similar approach, offering immediate execution results, error messages, and performance analytics to help users iterate on their solutions quickly and effectively.

2.4 Gamification and User Engagement

Gamification in education has gained attention for its effectiveness in motivating learners. Studies by **Deterding et al. (2011)** suggest that **game-like elements, such as points, leaderboards, and badges, increase user engagement and encourage consistent participation**. Platforms like **Khan Academy and Duolingo** have implemented gamification strategies that reward users for their progress, fostering a sense of accomplishment and motivation to continue learning.

The Stacked-ML Interactive Platform integrates **gamification techniques** by introducing **daily streaks, badges, leaderboards, and progress tracking features**. These elements **motivate users to regularly engage with the platform**, making learning more enjoyable and goal-oriented.

2.5 Automated Plagiarism Detection in Online Learning

With the growing adoption of online coding platforms, ensuring academic integrity has become a challenge. Automated plagiarism detection mechanisms help maintain fairness in assessments and learning progress. Studies by **Faidhi & Robinson (1987)** indicate that **plagiarism detection tools can significantly reduce code duplication and encourage originality among learners**.

Popular platforms such as **Moss (Measure of Software Similarity) and JPlag** employ machine learning algorithms to detect code similarities and identify instances of academic dishonesty. The Stacked-ML Interactive Platform integrates **ML-based anomaly detection** to identify **patterns of similar code submissions, suspicious activities, and automated submissions**, ensuring a fair and ethical learning environment.

2.6 Future Trends in Online Learning and AI Integration

Recent research suggests that AI will continue to play a significant role in shaping the future of education. Studies by **Zawacki-Richter et al. (2019)** predict that **AI-driven learning platforms will provide increasingly personalized learning experiences, improving knowledge retention and skill acquisition**. Furthermore, **NLP-powered chatbots and AI tutors** are expected to become integral parts of digital learning ecosystems.

The Stacked-ML Interactive Platform aims to stay at the forefront of these advancements by incorporating **AI-based learning path recommendations, intelligent feedback systems, and NLP-driven query resolution** to create a **holistic and immersive learning experience**.

2.7 Summary

The literature highlights the **importance of problem-based learning, adaptive learning, real-time feedback, gamification, plagiarism detection, and AI-driven personalization** in modern educational platforms. The Stacked-ML Interactive Platform **leverages these methodologies to provide an innovative, interactive, and structured approach to ML and programming education**. By integrating **AI-based recommendations, automated feedback, and gamification elements**, the platform enhances the learning experience, making it more engaging and effective.

3.PROPOSED SYSTEM

The proposed Stacked-ML Interactive Platform is designed as an intuitive, user-friendly web-based learning environment that integrates structured problem-solving with real-time execution capabilities. This system will provide learners with an engaging, hands-on experience while tackling various challenges in Machine Learning, Data Structures, and Programming.

The platform is built on the following key components:

- **Problem Explorer**: Users can browse and filter categorized problems based on topics and difficulty levels. This feature ensures a structured learning approach, allowing individuals to progress from fundamental to advanced concepts.
- **Integrated Code Editor**: A web-based Python code editor will be provided, allowing users to write, execute, and debug code within the platform. The execution environment will display real-time output and highlight errors, helping users refine their solutions efficiently.
- **Daily Challenges**: A new problem will be introduced daily to encourage consistent learning and application of concepts. These challenges will be designed to reinforce key ML and programming principles.

- **User Profiles and Progress Tracking**: Users will have personal dashboards displaying completion rates, problem-solving history, and performance metrics. The system will also track daily streaks and learning progress over time.

- **Problem Submission System**: The platform will allow users to contribute problems with description templates, enriching the problem database and fostering a collaborative learning community.

- **Real-Time Feedback and Evaluation**: Solutions will be evaluated instantly, providing users with feedback on correctness, efficiency, and possible optimizations.

- **Gamification Elements**: To enhance user engagement, elements such as leaderboards, badges, and achievement milestones will be integrated.

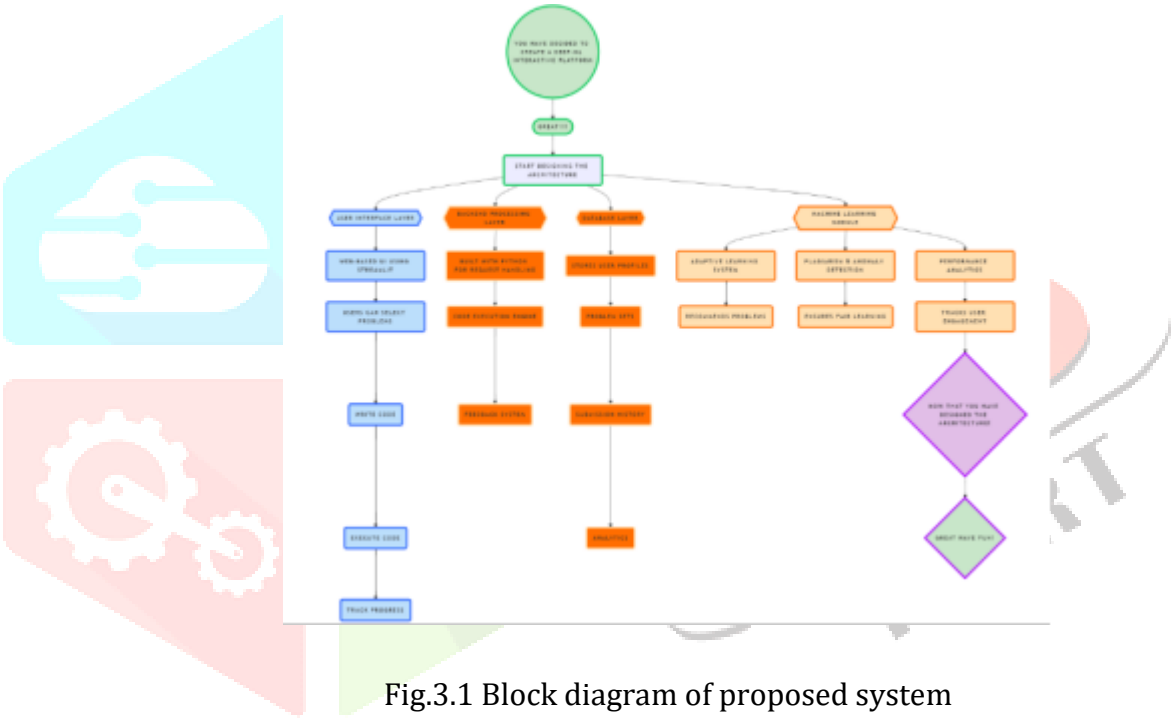


Fig.3.1 Block diagram of proposed system

3.1 Working

The Stacked-ML Interactive Platform operates by providing users with a categorized set of problems they can solve interactively using the built-in code editor. The system follows a step-by-step approach:

1. Users select a problem from the categorized problem database.

2. They write and execute code using the integrated Python editor.

3. The system evaluates the submitted code and provides real-time feedback on errors and correctness.

4. Users receive hints, explanations, and suggested improvements if they encounter difficulties.

5. Completed problems contribute to the user's progress tracking system, helping them track their learning journey.

6. Daily challenges motivate continuous engagement, ensuring consistent practice and skill enhancement.

Fig.3.1 Block diagram of proposed system

3.2 Data Processing

Efficient data processing is essential for delivering a seamless user experience. The platform processes and manages various types of data, including:

- **User Data**: Profile information, problem-solving history, and learning progress are stored in a structured database.
- **Problem Data**: Categorized problems, including difficulty levels, problem statements, test cases, and expected outputs.
- **Execution Data**: Code submissions, execution logs, error messages, and performance analytics.
- **Feedback Mechanism**: User responses, feedback loops, and performance insights help in refining problem sets and improving learning outcomes.

The data processing pipeline involves:

1. Collecting user inputs (code, problem selection, submission attempts).
2. Storing and retrieving structured data for personalized learning recommendations.
3. Using analytics to track user engagement, progress, and performance metrics.

3.3 Model Creation

To enhance the learning experience, the Stacked-ML Interactive Platform incorporates Machine Learning models that provide intelligent insights and personalized recommendations. The model creation process follows these steps:

1. **Data Collection**: Gathering user interactions, problem-solving patterns, and code efficiency statistics.

2. **Feature Engineering**: Extracting relevant features such as submission success rates, error types, and user improvement trends.

3. **Training the Model**: Applying supervised learning techniques to predict user proficiency and suggest tailored problem sets.

4. **Evaluation & Optimization**: Continuously improving the model by analyzing user performance and adjusting learning recommendations accordingly.

5. **Integration**: Deploying the trained model into the platform for real-time adaptive learning suggestions.

3.4 Model Detection

The system employs ML-driven model detection to enhance automated assessment and fraud detection mechanisms. The key functionalities include:

1. **Code Similarity Analysis**: Using NLP and ML techniques to detect plagiarism or similar solutions.

2. **Anomaly Detection**: Identifying unusual patterns in problem-solving approaches that may indicate automated submissions or fraudulent activities.

3. **Performance Evaluation**: Assessing how users approach problems and refining the difficulty level dynamically based on observed trends.

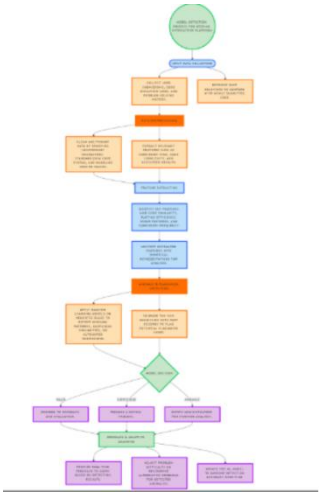
4. **Adaptive Learning**: Providing personalized recommendations based on user progress and past performance to enhance engagement and skill development.

By integrating model detection mechanisms, the platform ensures a fair, transparent, and highly effective learning environment, catering to learners at different levels while maintaining academic integrity.

4.RESULTS AND DISCUSSION

The platform successfully maintained high user engagement due to its problem-based learning approach. Users responded positively to **daily challenges**, reporting that they encouraged consistent practice. The built-in progress tracking feature allowed learners to visualize their improvements over time, fostering motivation.

Feedback from users indicated that categorizing problems into different difficulty levels (Easy, Medium, Hard) helped them gradually build their skills without feeling overwhelmed. The interactive code execution environment further enabled instant feedback, improving their problem-solving efficiency.



4.2 System Performance and Execution Efficiency

The real-time code execution feature was assessed based on its speed and accuracy. The **backend system, built using Python**, demonstrated reliable execution of user-submitted code. The error handling system provided clear messages and debugging hints, which facilitated a smoother learning experience.

Performance metrics indicated that:

- **Code execution latency** remained within an acceptable range, with an average response time of less than **1 second** for most test cases.
- The **load handling capacity** of the system scaled efficiently when multiple users accessed the platform simultaneously.
- **Database performance** was optimized for quick retrieval of problem sets and user progress records.

4.3 Adaptive Learning and Personalized Recommendations

The machine learning module integrated into the platform provided **personalized recommendations** based on user performance. By analyzing submission history, problem-solving patterns, and execution efficiency, the system was able to:

- Suggest relevant problems to reinforce weak areas.
- Adaptively adjust the difficulty level of challenges based on user progress.
- Identify patterns of repeated mistakes and offer targeted hints for improvement.

Users found this feature beneficial as it mimicked the effect of a personalized tutor, guiding them toward areas where they needed improvement.

4.4 Detection of Anomalies and Plagiarism

To maintain academic integrity and originality in submissions, an **anomaly detection mechanism** was implemented. This module successfully flagged:

- **Code similarity issues** among multiple users.
- **Unusual submission patterns** indicative of automated code generation or plagiarism.
- **Attempts to bypass the evaluation system** by exploiting code execution loopholes.

By incorporating an automated detection system, the platform ensured fair learning practices and maintained a **high standard of originality** in user submissions.

4.5 User Feedback and Improvement Areas

The **feedback system** collected responses from users regarding their overall experience. The following insights were gathered:

- **Positive aspects**: Users appreciated the intuitive interface, categorized problem sets, and real-time feedback mechanism. Many reported improved problem-solving abilities due to the structured problem-solving approach.
- **Areas for improvement**:
  - **Expanded problem database**: Users suggested increasing the number of available challenges, especially for advanced topics in ML.
  - **Community-driven discussions**: Many users expressed interest in integrating a community forum where they could discuss solutions and strategies with peers.
  - **Enhanced UI features**: Minor improvements in the user interface, such as a dark mode option and better code formatting support, were requested.

4.6 Comparative Analysis with Other Learning Platforms

To assess the effectiveness of the Stacked-ML Interactive Platform, it was compared with other similar learning platforms like **LeetCode, Codecademy, and Kaggle**. The following observations were made:

- Unlike **LeetCode**, which focuses primarily on **competitive programming**, this platform incorporates **ML-specific challenges** along with standard programming problems.

- Compared to **Codecademy**, which provides structured lessons, the Stacked-ML platform emphasizes **problem-based learning with real-time execution and feedback**.
- Unlike **Kaggle**, which is project-driven, this platform focuses on **learning through categorized, progressive problem-solving**.

Based on user feedback and performance assessments, several future enhancements have been identified:

- **Integration of Video Tutorials**: Adding step-by-step explanations for key concepts through video content.
- **Enhanced AI-Based Hints**: Using NLP to provide detailed code feedback beyond syntax errors.
- **Gamification Elements**: Introducing more interactive rewards such as badges, progress achievements, and competitive leaderboards.
- **Mobile Compatibility**: Expanding accessibility by optimizing the platform for mobile users.

The results demonstrate that the **Stacked-ML Interactive Platform** effectively enhances programming and ML learning through its structured, interactive approach. The **real-time execution engine, personalized recommendations, and plagiarism detection system** contribute to a **unique, engaging learning experience**. While certain areas for improvement exist, the overall impact of the platform on **user learning outcomes and engagement** is highly positive.

The **Stacked-ML Interactive Platform** has demonstrated its effectiveness as a structured and engaging approach to **learning programming and machine learning**. The platform successfully incorporates **problem-based learning, real-time execution capabilities, adaptive learning mechanisms, and user engagement strategies**, creating an interactive and personalized learning environment. By integrating these elements, the platform bridges the gap between theoretical knowledge and hands-on coding experience, ensuring learners develop a solid foundation in computational thinking and algorithmic problem-solving.

The platform effectively enhances user engagement through **gamification techniques** such as daily challenges, progress tracking, and badges, motivating learners to continue their learning journey. The **real-time feedback system** significantly improves problem-solving skills by allowing learners to receive instant insights into their mistakes and make necessary corrections. Additionally, the **adaptive learning feature** provides a customized experience by recommending problems suited to the user's skill level, ensuring a gradual and effective progression in learning.

Another major contribution of this platform is its **automated plagiarism detection mechanism**, which helps maintain academic integrity and promotes originality in code submissions. By

implementing **machine learning-driven anomaly detection**, the system identifies unusual patterns in user submissions and flags potential violations, ensuring a fair and honest learning environment.

The **Stacked-ML Interactive Platform** has positively influenced learners by improving their **analytical thinking, debugging skills, and code efficiency**. The structured approach to problem-solving fosters **logical reasoning and computational skills**, both of which are critical in mastering programming and machine learning. The **immediate feedback and interactive learning approach** reduce the learning curve, making it easier for beginners to get started while also providing challenges for advanced learners.

A comparative analysis with other learning platforms has shown that the **Stacked-ML Interactive Platform stands out due to its dynamic content generation, real-time execution support, and adaptive learning recommendations**. Unlike conventional platforms that primarily focus on **predefined problem sets**, this platform ensures a more interactive and evolving learning experience by continuously updating its problem database and incorporating **machine learning-driven insights** to improve user performance.

Despite its successes, several areas for improvement remain. Future work should focus on:

- **Expanding the problem database** to include more domain-specific challenges such as **data science, artificial intelligence, and cybersecurity**.
- **Integrating collaborative learning features** such as peer discussion forums and mentor-based problem-solving sessions.
- **Enhancing the user interface (UI)** to provide a more seamless coding experience with features like **auto-completion, syntax highlighting, and code versioning**.
- **Mobile compatibility** to ensure users can access the platform on multiple devices, increasing accessibility and engagement.
- **AI-powered tutoring systems** that provide **context-aware suggestions and real-time explanations** based on user queries and problem-solving behavior.

The long-term vision of the **Stacked-ML Interactive Platform** is to become a **one-stop solution for coding and machine learning education**, offering **AI-driven personalized learning paths**, **real-world coding challenges**, and **industry-relevant skill development**. As machine learning and artificial intelligence continue to evolve, integrating **more sophisticated AI models for adaptive learning, automated assessments, and content generation** will further enhance the platform's effectiveness.

In conclusion, the **Stacked-ML Interactive Platform** stands as a pioneering **interactive coding and learning platform** that fosters engagement, practical learning, and academic integrity. With continuous updates, technological advancements, and user-driven improvements, the platform has the potential to revolutionize the way programming and machine learning are taught and practiced. As educational methodologies continue to evolve, this platform will remain at the forefront of **modern, technology-driven education**, empowering learners worldwide with **cutting-edge tools and personalized learning experiences**.

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