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Design and Development of an AI-Powered DSA Practice and Learning Platform

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Abstract- This paper presents a comprehensive DSA (Data Structures and Algorithms) practice platform designed to enhance problem-solving skills through personalized learning and performance-driven feedback. The system integrates user and admin modules, enabling efficient management of topics, quizzes, coding problems, and assessments. Users can learn concepts, attempt MCQ-based quizzes, and solve coding problems, earning experience points (XP) to encourage engagement. A machine learning–based recommendation engine analyzes user performance, including accuracy, time complexity, and coding efficiency, to suggest optimized learning paths and identify weak areas. Additionally, an AI-powered code analysis module evaluates submissions and provides improvement insights. The platform includes coding tests covering multiple topics, generating detailed performance summaries to guide learners effectively. Supporting features such as real-time notifications, flash notes, admin-user chat support, and topic-based community discussions further enrich the learning experience. The proposed system aims to bridge the gap between theoretical understanding and practical coding proficiency by offering an adaptive, interactive, and scalable environment for DSA preparation.

Keywords- adaptive learning, coding platform, data structures and algorithms, machine learning recommendation, performance analysis, problem solving.

I. INTRODUCTION

The proposed system is an intelligent DSA (Data Structures and Algorithms) practice platform designed to provide a structured, personalized, and interactive learning experience. Unlike traditional learning methods such as textbooks and static tutorials, as well as existing coding platforms, the system addresses the lack of adaptive guidance, detailed feedback, and personalized learning paths.
The platform integrates learning, assessment, performance tracking, and recommendation into a single ecosystem. It allows users to explore DSA topics, understand theoretical concepts, and practice through quizzes and coding exercises. A gamified reward system using experience points (XP) is incorporated to enhance user engagement and motivation.

The system evaluates user performance using metrics such as quiz accuracy, coding success rate, time taken to solve problems, and inferred time complexity. Based on this analysis, it provides personalized recommendations, identifies weak areas, and generates a tailored learning path, ensuring focused and efficient learning.

The platform also includes an AI-powered code analysis module that evaluates code beyond correctness by analyzing efficiency, structure, and optimization, and provides actionable feedback for improvement.

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The core features of the system include:

- Personalized Learning Path: Generates adaptive learning paths based on user performance and progress.
- AI-Based Code Analysis: Evaluates code quality, efficiency, and structure with improvement suggestions.
- Performance Tracking: Monitors metrics such as accuracy, success rate, and time complexity.
- Coding Tests and Reports: Conducts multi-topic assessments and provides detailed performance reports.
- Gamification (XP System): Rewards users to improve engagement and consistency.
- Additional Features: Includes flash notes, real-time notifications, discussion groups, and chat support.
- Admin Module: Enables management of topics, quizzes, coding problems, and user analytics.
- In this project, the aim is to develop a smart, adaptive, and interactive platform that bridges the gap between theoretical knowledge and practical implementation, thereby improving DSA learning effectiveness and skill development.

II. PROBLEM STATEMENT

In today's technology-driven world, mastering Data Structures and Algorithms (DSA) is essential for efficient problem-solving and success in technical interviews. However, learners often face difficulties in understanding concepts and applying them effectively due to the lack of structured and personalized learning approaches. Although various online platforms provide coding practice and theoretical resources, they fail to deliver an integrated and adaptive learning experience.

Most existing systems focus on limited functionalities such as problem-solving or quizzes without offering intelligent guidance and detailed performance analysis. As a result, users encounter several challenges:

- Difficulty in identifying weak areas and improving them systematically
- Lack of personalized learning paths based on individual performance
- Limited feedback focused only on code correctness rather than efficiency and optimization
- Absence of integrated AI-based code analysis for deeper evaluation
- Low engagement due to lack of motivation and interactive features

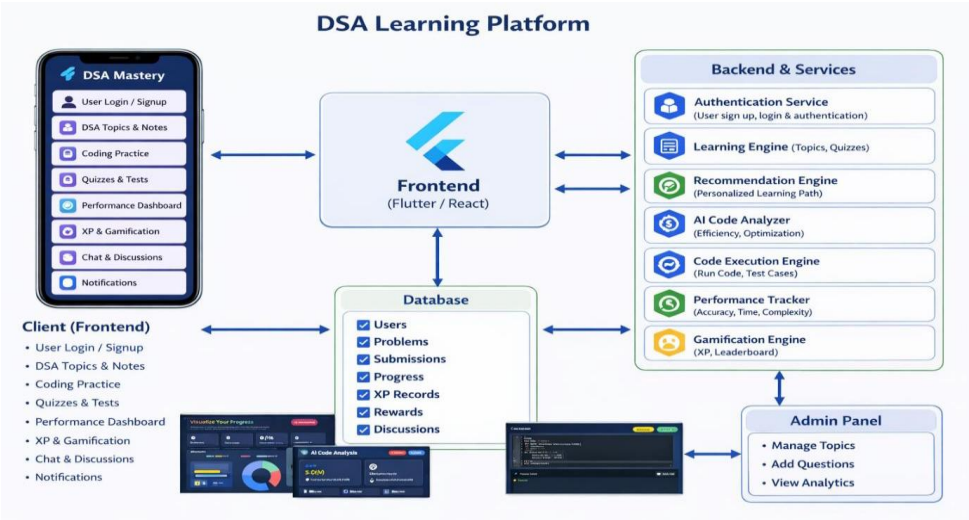

Figure 1: DSA Learning Platform System Architecture.

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Additionally, existing platforms do not effectively combine performance tracking, recommendation systems, and collaborative learning features within a single unified framework. This creates a gap between theoretical knowledge and practical implementation.

Therefore, there is a need for an intelligent and integrated DSA learning platform that provides personalized recommendations, real-time feedback, performance analysis, and interactive features, enabling users to enhance both conceptual understanding and coding proficiency in a structured and efficient manner.

Table 1: Properties of Structure.

Properties	Description
Application Name	DSA Learning & Practice Platform
Platform	Web-based Application
Frontend	HTML, CSS, JavaScript
Backend	Python
Database	MySQL
Programming Language	Python
Framework	Flask
IDE/Tools	VS Code, PyCharm, MySQL Workbench
Code Execution	Integrated Code Runner / Online Compiler
Evaluation System	Test Case-Based Automated Evaluation
AI Features	Machine Learning-based Recommendation System, Code Analysis
Main Features	Problem Solving, Personalized Learning Path, Code Analysis, Gamification (XP, Badges), Leaderboard, Notifications
Target Users	Students and beginners learning Data Structures & Algorithms
Update Mechanism	Dynamic updates based on user performance analytics
Security	User Authentication and Secure Data Handling
Architecture Type	Three-tier (Presentation, Business Logic, Data Layer)
Development Model	Agile Methodology

III. CONCLUSION

The proposed DSA Practice Platform demonstrates an integrated and intelligent approach to learning Data Structures and Algorithms by combining theoretical concepts with practical problem-solving. It brings together features such as topic-based learning, MCQ quizzes, coding practice, coding tests, and performance tracking in a unified system, making the learning process structured and effective. A key contribution is the integration of a machine learning–based recommendation system and AI-powered code analysis, which enable personalized learning and detailed feedback. These features help users identify strengths and weaknesses, improve coding skills, and follow a guided learning path, while gamification through XP points enhances motivation and engagement.

Additionally, features like real-time notifications, flash notes, admin support, and community discussions create a collaborative and interactive learning environment. From an implementation perspective, the use of Flask for backend, SQLite for database management, and HTML, CSS, and JavaScript for frontend ensures a lightweight and efficient system. Overall, the platform bridges the gap between traditional learning and modern data-driven education by improving conceptual understanding, coding proficiency, and user engagement, with strong potential to evolve into a comprehensive intelligent learning system.

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