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CODEHUB: CODING PLATFORM

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Abstract: The rapid growth of computer science education and competitive programming has increased the demand for efficient online platforms that support coding practice, assessment, and skill evaluation. Traditional classroom-based learning and manual evaluation methods often lack scalability, instant feedback, and real-time performance analysis. To address these challenges, this paper presents CodeHub, a full-stack online coding practice and evaluation platform designed to help students enhance their programming and problem-solving skills.

CodeHub provides a centralized environment where users can practice Data Structures and Algorithms (DSA), solve coding problems, participate in contests, and receive instant code evaluation through an integrated online judge system. The platform supports secure user authentication, role-based access for students and administrators, and automated code execution using APIs such as Judge0. Built using modern web technologies including React, Node.js, PostgreSQL, and RESTful APIs, CodeHub ensures scalability, reliability, and a user-friendly experience. Experimental usage shows that CodeHub improves learning efficiency by providing real-time feedback, standardized evaluation, and continuous skill assessment, making it a valuable tool for modern programming education.

Keywords: Online Coding Platform, CodeHub, Data Structures and Algorithms, Code Evaluation, Judge0, Full-Stack Development, Programming Education

I. INTRODUCTION

Programming skills play a crucial role in computer science education and technical careers. Students are expected to develop strong logical thinking, algorithmic knowledge, and hands-on coding experience. However, traditional learning approaches often fail to provide sufficient practice opportunities, instant feedback, and real-world coding exposure. Manual evaluation of programming assignments is time-consuming and inconsistent, especially when dealing with large numbers of learners.

With the rise of online learning platforms, there is a growing need for integrated systems that support coding practice, automated evaluation, and performance tracking. Online coding platforms allow learners to practice anytime, experiment with multiple programming languages, and receive immediate feedback on their solutions. CodeHub is designed to address these needs by offering a unified platform for coding practice, assessment, and learning management. By combining modern web technologies with automated code execution services, CodeHub enhances accessibility, efficiency, and learning outcomes in programming education.

A. Project Description

CodeHub is a full-stack web-based coding practice and evaluation platform developed to support students, beginners, and competitive programmers. The platform enables users to solve coding problems related to Data Structures and Algorithms, submit code online, and receive instant evaluation results. Code execution and validation are handled using an external online judge API, ensuring accuracy and language flexibility.

The system includes user authentication, role-based access control, problem management, contest creation, and result analysis. Administrators can add new problems, manage contests, and monitor user performance, while students can practice coding, participate in contests, and track their progress. CodeHub aims to provide a scalable, interactive, and efficient learning environment for programming education.

B. Motivation

The motivation behind developing CodeHub arises from the limitations of traditional programming education methods. Manual assignment evaluation is slow and prone to inconsistencies, while students often lack access to structured practice platforms. Existing coding platforms may be costly, complex, or unsuitable for academic use.

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CodeHub is motivated by the need for an affordable, academic-friendly, and scalable coding platform that provides instant feedback, fair evaluation, and continuous learning support. The project aims to reduce instructor workload, improve student engagement, and bridge the gap between theoretical learning and practical coding skills.

II. RELATED WORK

Paper [1] presents the design and implementation of an online coding practice platform aimed at improving programming skills among students. The study focuses on providing a web-based interface where users can solve coding problems and receive instant feedback. The system demonstrates how interactive platforms enhance learner engagement and reduce dependency on traditional classroom methods.

Paper [2] explores the role of RESTful APIs in full-stack web applications used for coding evaluation systems. The authors highlight the importance of efficient communication between frontend and backend layers to manage user authentication, problem submissions, and result processing. The study emphasizes scalability and maintainability in modern coding platforms.

Paper [3] discusses the use of NoSQL databases for storing and managing dynamic data in programming practice systems. The flexibility of document-oriented databases is highlighted for handling user profiles, coding problems, submissions, and execution histories. The study concludes that NoSQL databases are suitable for applications with frequently changing data structures.

Paper [4] reviews security mechanisms adopted in online coding platforms, with particular focus on JSON Web Token (JWT) based authentication. The paper explains how token-based authentication enables stateless sessions, improves system security, and protects APIs from unauthorized access. It also highlights the importance of secure role-based access control in multi-user environments.

Paper [5] examines the integration of intelligent assistance features in web-based learning platforms. The authors highlight how automated feedback systems and guided assistance improve user learning experience without relying on complex artificial intelligence models. Such features help users debug code efficiently and enhance overall engagement.

III. METHODOLOGY

The development of CodeHub follows a systematic and modular approach based on full-stack web application principles. The methodology is divided into multiple stages to ensure efficiency, scalability, and security.

A. System Design

CodeHub is designed using a three-tier architecture consisting of the presentation layer, application layer, and data layer. This layered approach improves maintainability and allows independent updates to each module without affecting the overall system.

B. User Authentication and Authorization

Secure user authentication is implemented using JSON Web Tokens (JWT). Users are required to register and log in before accessing the platform. Role-based access control is applied to differentiate between users and administrators, ensuring secure handling of coding problems and submissions.

C. Coding and Code Execution

The platform provides an interactive code editor where users can write and submit solutions. Submitted code is processed through a secure code execution engine that compiles and executes the program against predefined test cases. The system captures output, errors, and execution status to provide instant feedback to the user.

D. Data Management

All user details, coding problems, submissions, and execution results are stored in a structured database. Efficient data retrieval techniques are used to maintain user progress, submission history, and performance analytics.

E. Result Evaluation and Feedback

The system evaluates submitted code based on correctness, output matching, and execution status. Results are displayed immediately, enabling users to identify errors and improve their solutions. This real-time feedback mechanism enhances learning effectiveness.

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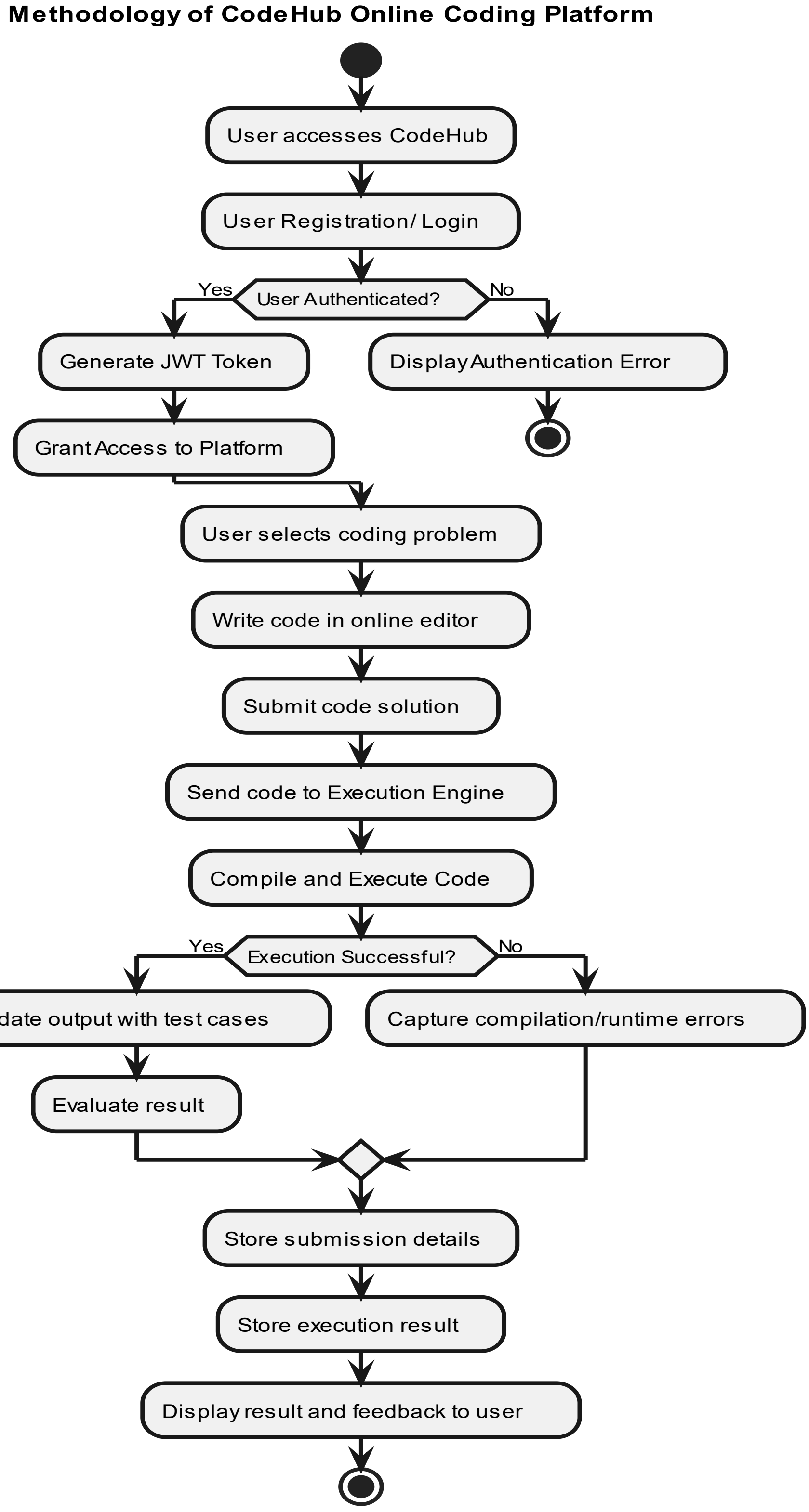
Methodology of CodeHub Online Coding Platform
User accesses CodeHub
User Registration/ Login
User Authenticated?
Yes
No
Generate JWT Token
Display Authentication Error
Grant Access to Platform
User selects coding problem
Write code in online editor
Submit code solution
Send code to Execution Engine
Compile and Execute Code
Execution Successful?
Yes
No
Validate output with test cases
Capture compilation/runtime errors
Evaluate result
Store submission details
Store execution result
Display result and feedback to user

Fig.1. Flowchart of methodology

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F. Implementation Flow

1. The user accesses the CodeHub web application through a browser.
2. The user registers or logs into the system using valid credentials.
3. The backend verifies user credentials and generates a JWT token for secure access.
4. After successful authentication, the user is redirected to the coding dashboard.
5. The user selects a coding problem from the problem list.
6. The user writes code using the integrated online code editor.
7. The written code is submitted to the backend server.
8. The backend forwards the code to the code execution engine.
9. The execution engine compiles and runs the code against predefined test cases.
10. The execution result (output or error) is returned to the backend.
11. The backend evaluates the result and stores submission details in the database.
12. The final result and feedback are displayed to the user..

G. Hardware and Software Requirements

- CodeHub requires a 64-bit system with an Intel Core i3 processor or higher, at least 4 GB RAM, sufficient storage space, and a stable internet connection.
- The application can run on Windows, Linux, or macOS operating systems using any modern web browser.
- The frontend is developed using React.js with HTML, CSS, and JavaScript to provide a responsive user interface.
- The backend is implemented using Node.js and Express.js, with MongoDB used for database management and JWT for secure authentication.
- An online code execution engine such as Judge0 is integrated to compile, execute, and evaluate user-submitted programs.

IV. SYSTEM DESIGN AND IMPLEMENTATION FRAMEWORK

This section presents the system design, implementation, and evaluation approach of CodeHub, an online coding practice platform. The system is developed using a full-stack architecture with React.js for the frontend, Node.js and Express.js for backend services, and MongoDB for database management. A client–server model is followed to ensure scalability, security, and efficient user interaction.

A. System Architecture and Workflow

CodeHub adopts a modular architecture to support interaction between users, administrators, and system services

Frontend:

The React.js-based frontend provides interfaces for user authentication, problem listing, code editor, submission, and result display.

Backend:

Node.js with Express.js manages application logic, user authentication, problem handling, and communication through RESTful APIs.

Database:

MongoDB stores user data, coding problems, submissions, and execution results using a flexible schema.

Authentication:

JWT-based authentication ensures secure access and role-based authorization

Code Execution Engine:

An online compiler such as Judge0 is integrated to compile, execute, and evaluate user-submitted code in a secure environment.

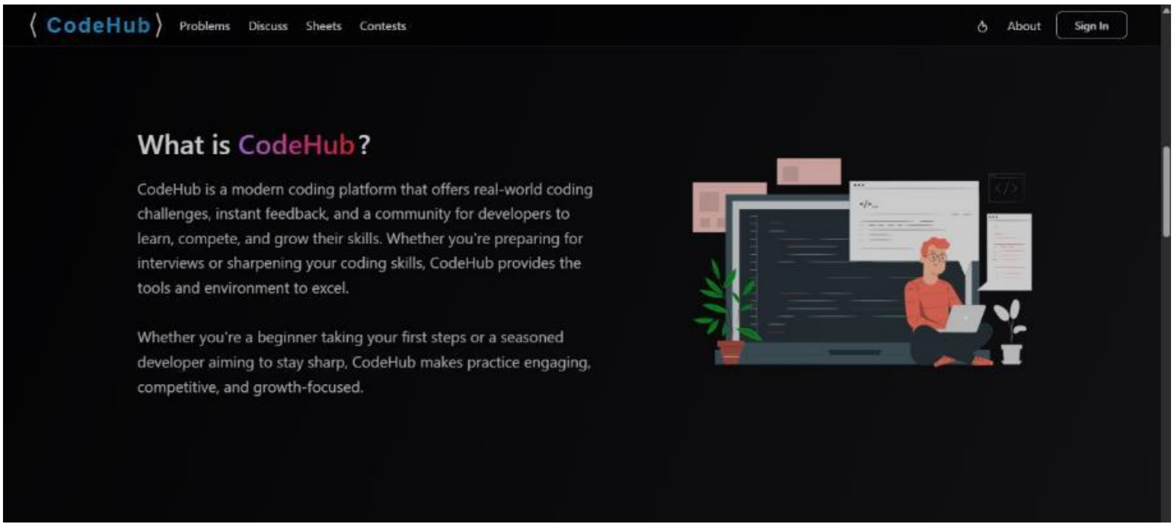
B. Application Setup and Execution

CodeHub operates as a single-page web application accessed through a browser. The frontend communicates with backend APIs for authentication, code submission, execution, and result retrieval, enabling real-time feedback.

C. Evaluation Strategy

The system is evaluated based on functionality, performance, security, and user experience. Testing confirms accurate code evaluation, secure authentication, smooth navigation, and reliable execution under normal operating conditions.

D. Results

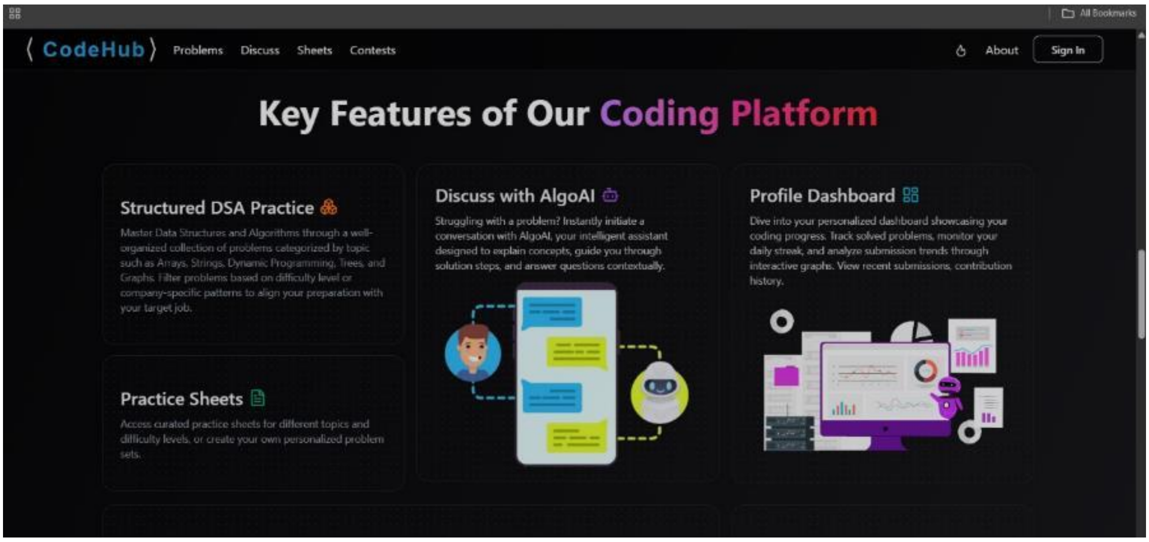


What is CodeHub?

CodeHub is a modern coding platform that offers real-world coding challenges, instant feedback, and a community for developers to learn, compete, and grow their skills. Whether you're preparing for interviews or sharpening your coding skills, CodeHub provides the tools and environment to excel.

Whether you're a beginner taking your first steps or a seasoned developer aiming to stay sharp, CodeHub makes practice engaging, competitive, and growth-focused.

Fig.2 User Interface of CodeHub Coding Platform.



Key Features of Our Coding Platform

Structured DSA Practice

Master Data Structures and Algorithms through a well-organized collection of problems categorized by topic such as Arrays, Strings, Dynamic Programming, Trees, and Graphs. Filter problems based on difficulty level or company-specific patterns to align your preparation with your target job.

Practice Sheets

Access curated practice sheets for different topics and difficulty levels, or create your own personalized problem sets.

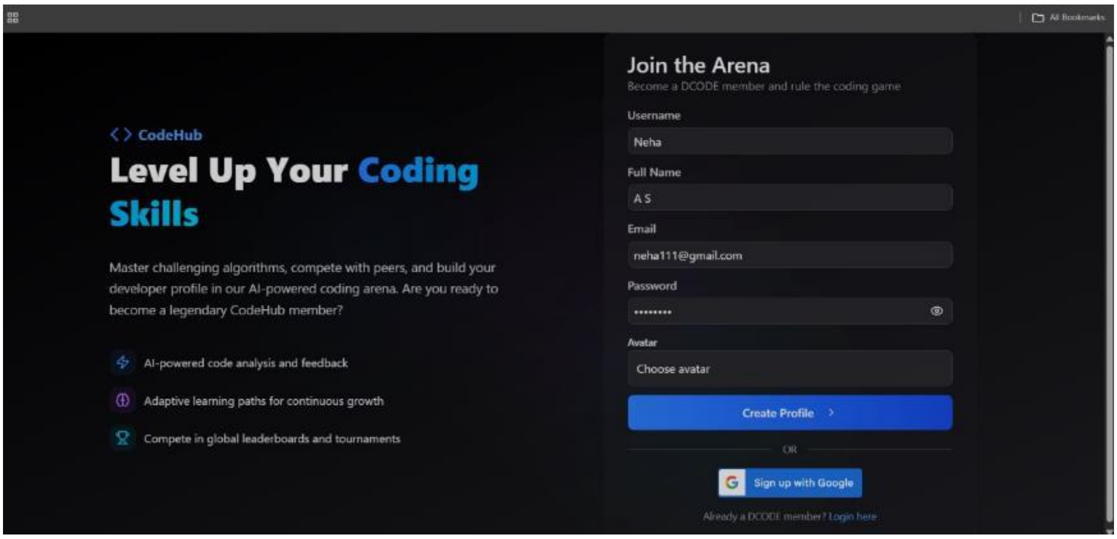
Discuss with AlgoAI

Struggling with a problem? Instantly initiate a conversation with AlgoAI, your intelligent assistant designed to explain concepts, guide you through solution steps, and answer questions contextually.

Profile Dashboard

Dive into your personalized dashboard showcasing your coding progress. Track solved problems, monitor your daily streak, and analyze submission trends through interactive graphs. View recent submissions, contribution history.

Fig.3 CodeHub Features Screen.



Level Up Your Coding Skills

Master challenging algorithms, compete with peers, and build your developer profile in our AI-powered coding arena. Are you ready to become a legendary CodeHub member?

- AI-powered code analysis and feedback
- Adaptive learning paths for continuous growth
- Compete in global leaderboards and tournaments

Join the Arena

Become a DCODE member and rule the coding game

Username: Neha

Full Name: A S

Email: neha111@gmail.com

Password: ••••••••

Avatar: Choose avatar

Already a DCODE member? Login here

Fig.4 User Registration Page of CodeHub.

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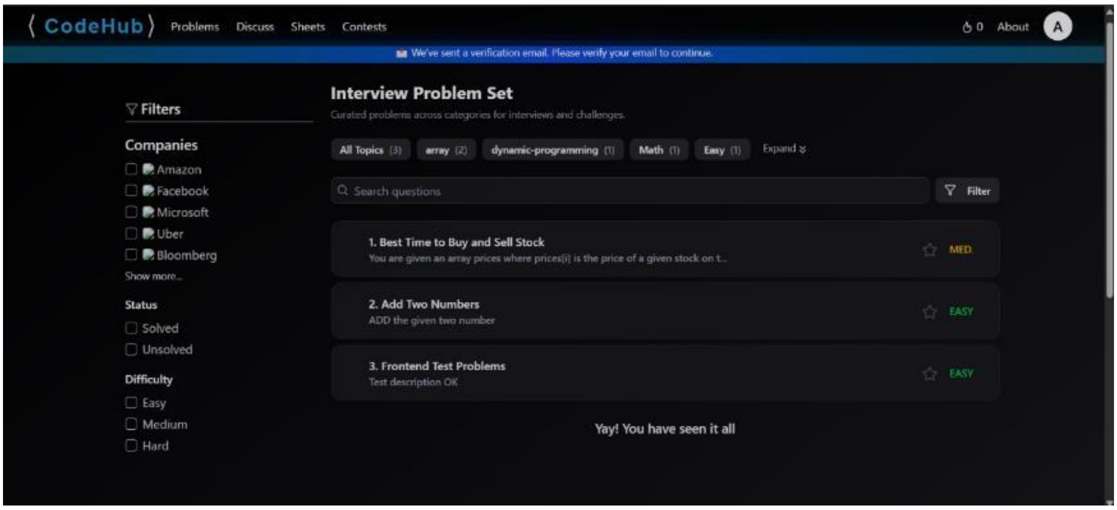


We've sent a verification email. Please verify your email to continue.

Interview Problem Set

Curated problems across categories for interviews and challenges.

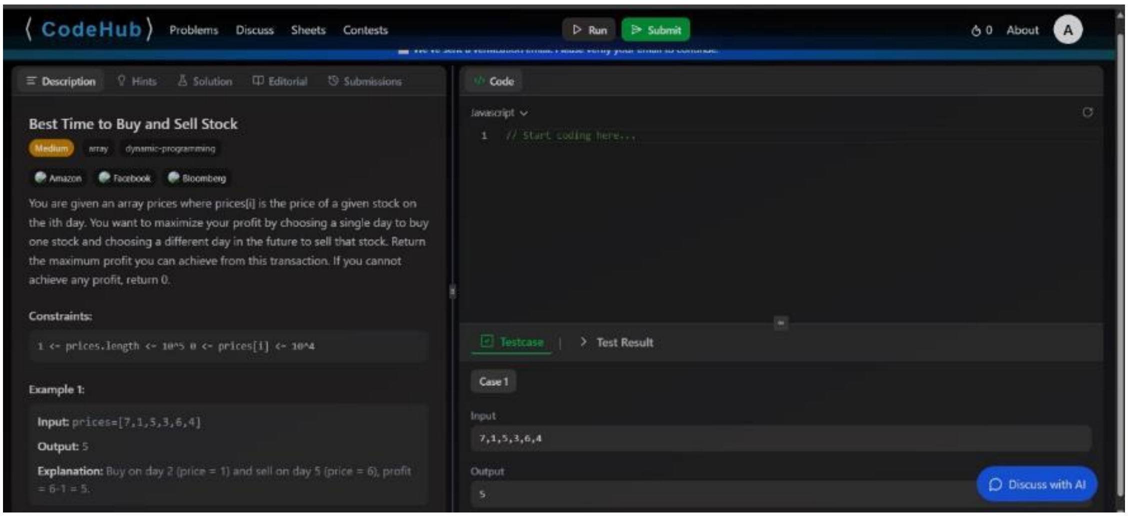
1. Best Time to Buy and Sell Stock
You are given an array prices where prices[i] is the price of a given stock on t...

2. Add Two Numbers
ADD the given two number

3. Frontend Test Problems
Test description OK

Yay! You have seen it all

Fig.5 Coding Problem Page.



Best Time to Buy and Sell Stock

You are given an array prices where prices[i] is the price of a given stock on the ith day. You want to maximize your profit by choosing a single day to buy one stock and choosing a different day in the future to sell that stock. Return the maximum profit you can achieve from this transaction. If you cannot achieve any profit, return 0.

Constraints:

```
1 <= prices.length <= 10^5 0 <= prices[i] <= 10^4
```

Example 1:

Input: prices=[7,1,5,3,6,4]

Output: 5

Explanation: Buy on day 2 (price = 1) and sell on day 5 (price = 6), profit = 6-1 = 5.

```
// Start coding here...
```

Input

```
7,1,5,3,6,4
```

Output

```
5
```

Fig.6 Code Editor and Program Execution Screen.

V. RESULTS AND DISCUSSION

The CodeHub platform was successfully implemented and tested to evaluate its functionality, performance, and usability. The system allowed users to register, log in securely, view coding problems, submit solutions, and receive real-time execution results. Integration of the online code execution engine enabled accurate compilation, execution, and evaluation of programs across supported languages.

Performance testing demonstrated smooth interaction between the frontend, backend, and execution engine with minimal response time during code submission and result retrieval. The use of RESTful APIs and MongoDB ensured efficient data storage and retrieval for user profiles, submissions, and execution logs. JWT-based authentication provided secure session management and protected access to platform features.

User interaction results indicated improved engagement due to the responsive interface and instant feedback mechanism. The modular architecture of CodeHub supports scalability and future enhancements such as advanced analytics, contest modules, and intelligent assistance features. Overall, the results confirm that CodeHub is an effective and reliable platform for online coding practice and skill development.

VI. CONCLUSION

This paper presented CodeHub, a full-stack online coding practice and evaluation platform designed to enhance programming skills through real-time code execution and feedback. The system integrates a responsive frontend, secure

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backend services, and an online code execution engine to provide an efficient and user-friendly learning environment. Experimental results demonstrate reliable performance, secure authentication, and accurate evaluation of user submissions. The modular architecture ensures scalability and ease of maintenance, making CodeHub suitable for academic and self-learning use. Future enhancements may include advanced analytics, competitive programming features, and intelligent assistance to further improve user engagement and learning outcomes.

VII. FUTURE WORK

Future enhancements of CodeHub may include support for additional programming languages and advanced problem categories such as competitive programming and system design challenges. Performance analytics and personalized learning dashboards can be integrated to track user progress and recommend problems based on skill level. The platform can also be extended with contest modules, real-time leaderboards, and plagiarism detection mechanisms. Incorporating intelligent assistance and cloud-based scalability will further improve system efficiency and user engagement.

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