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South East
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SETU Code Lab

Design Document

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Introduction

The purpose of this document is to outline the proposed design for SETU Code Lab. It will explore how each part of the project is intended to be implemented. It includes sections on hosting, sequence diagrams, important algorithms, database design and the user interface.

SETU Code Lab is an in-browser study tool intended to be used by students enrolled in computing related courses at SETU and their lecturers. Students can select and complete problems and view their results and statistics on their profile. Lecturers can create problems, and courses which allow them to assign problems to groups of students and easily track their progress. This will help students prepare for upcoming exams and coding interviews and will also help lecturers easily conduct and grade lab work. The platform will also use some gamification mechanics to keep students engaged.

Hosting

The system will be hosted using DigitalOcean's Droplet service. This is a virtual private server (VPS). The \$12 per month regular option provides 2GBs of RAM, 1 CPU, 50GB of SSD storage and 1TB of bandwidth which should be enough for SETU Code Lab with some optimization. The chosen operating system for this server is Ubuntu 24.04 as it is very stable, provides excellent Docker support and is familiar to the developer.

For security purposes an SSH key will be generated and used to access the server console. This is faster and more secure than the password option that is offered by DigitalOcean. The Github repository containing the project will be cloned onto the server and the needed dependencies will be installed such as Node.js, Node Package Manager (NPM) and Nginx for serving the frontend.

Architecture Diagram

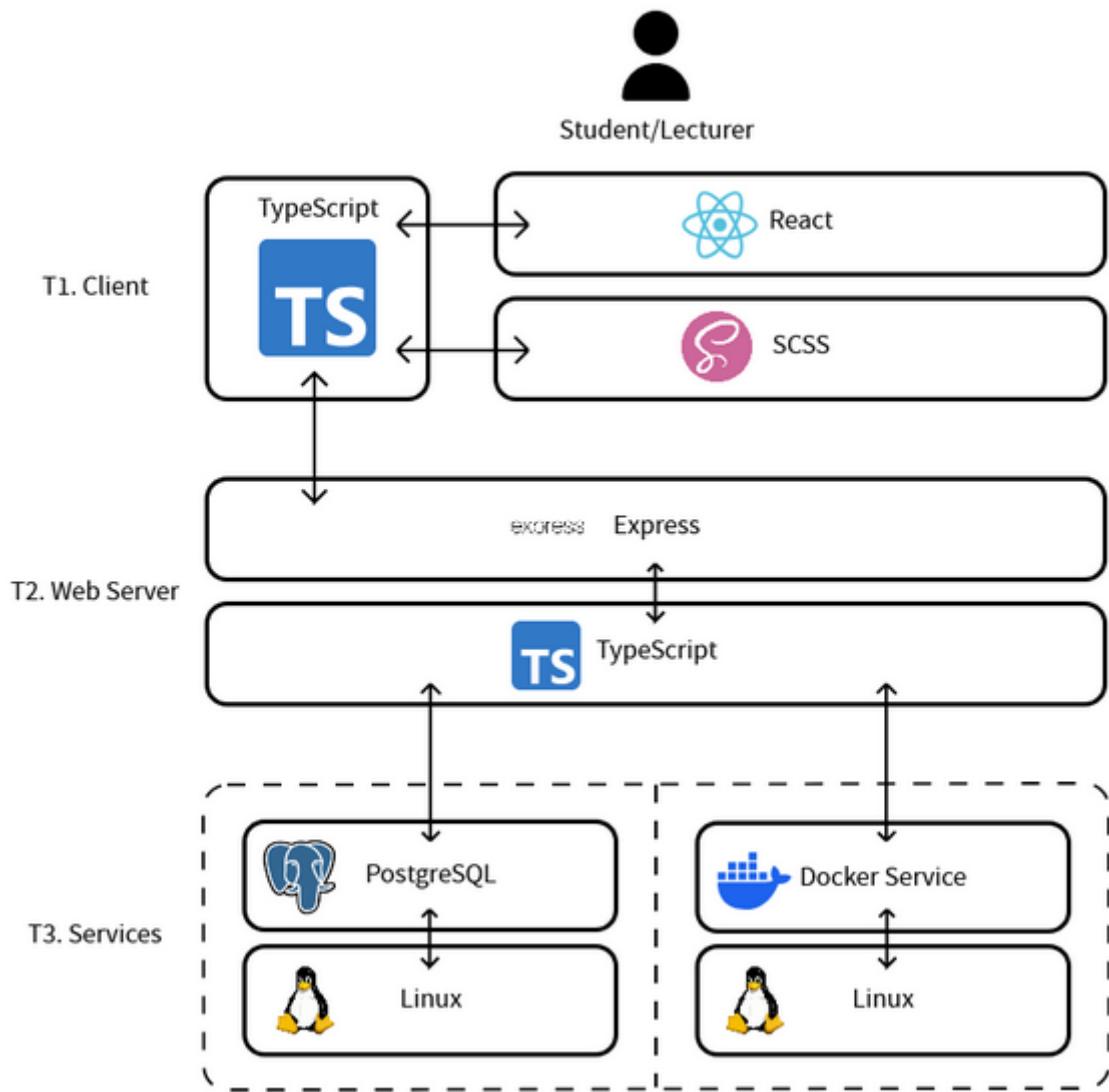


Figure 1. Architecture Diagram

SETU Code Lab uses a three-tier architecture. Tier one (T1) is the client and is built using React, Typescript and SCSS. This is where the user interface resides. Tier two (T2) is the web server and is implemented using Node.js (this is a JavaScript runtime which allows TypeScript to run on a web server) and Express.js which is a Node.js framework used to simplify the routing process. This is where the application logic resides. Tier three (T3) is the services layer and consists of a PostgreSQL database which stores all the application data and the Docker service which is used to create temporary containers in which user submitted code runs in isolation.

Sequence Diagrams

Solve a Problem

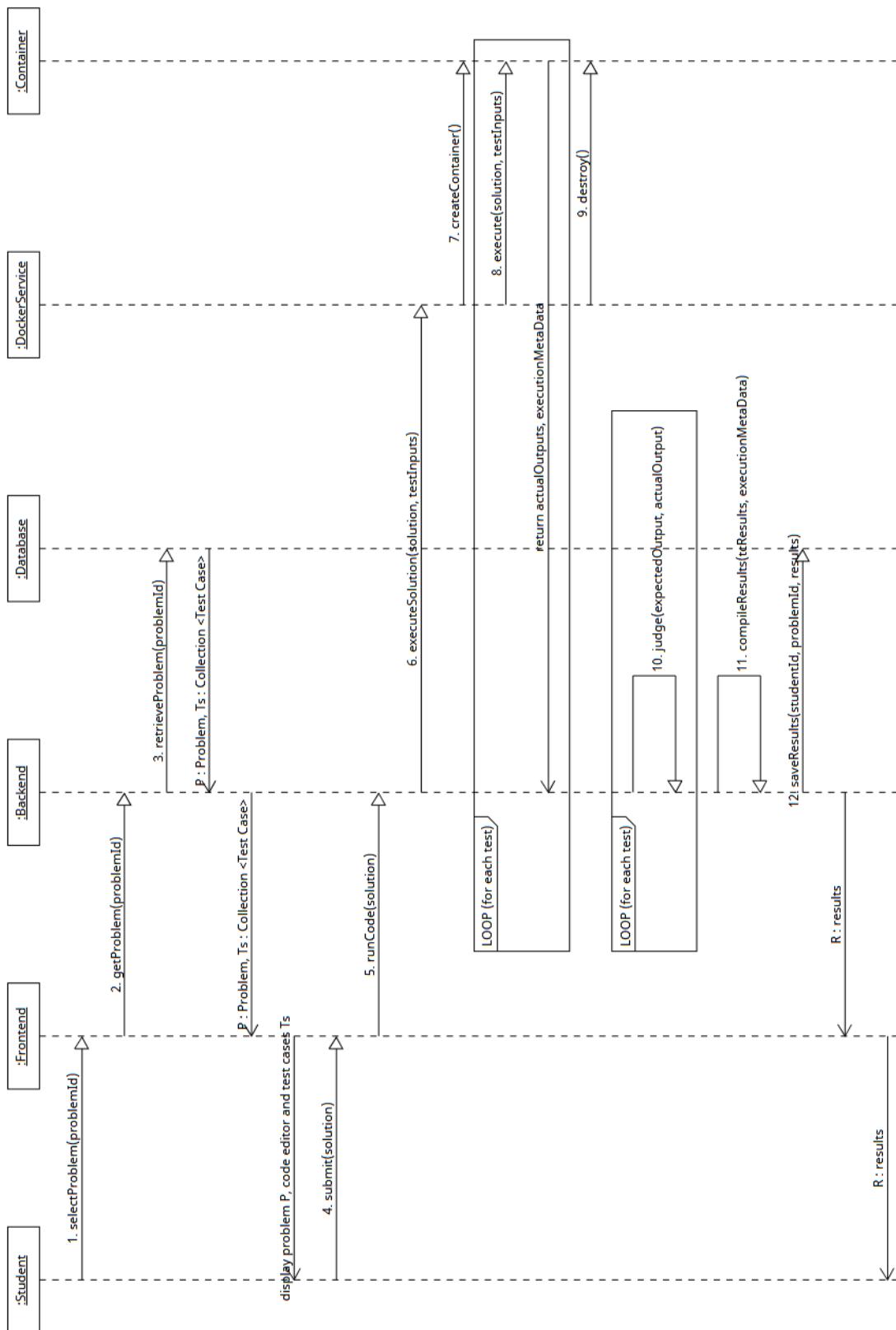


Figure 2. Solve a Problem sequence diagram

Login

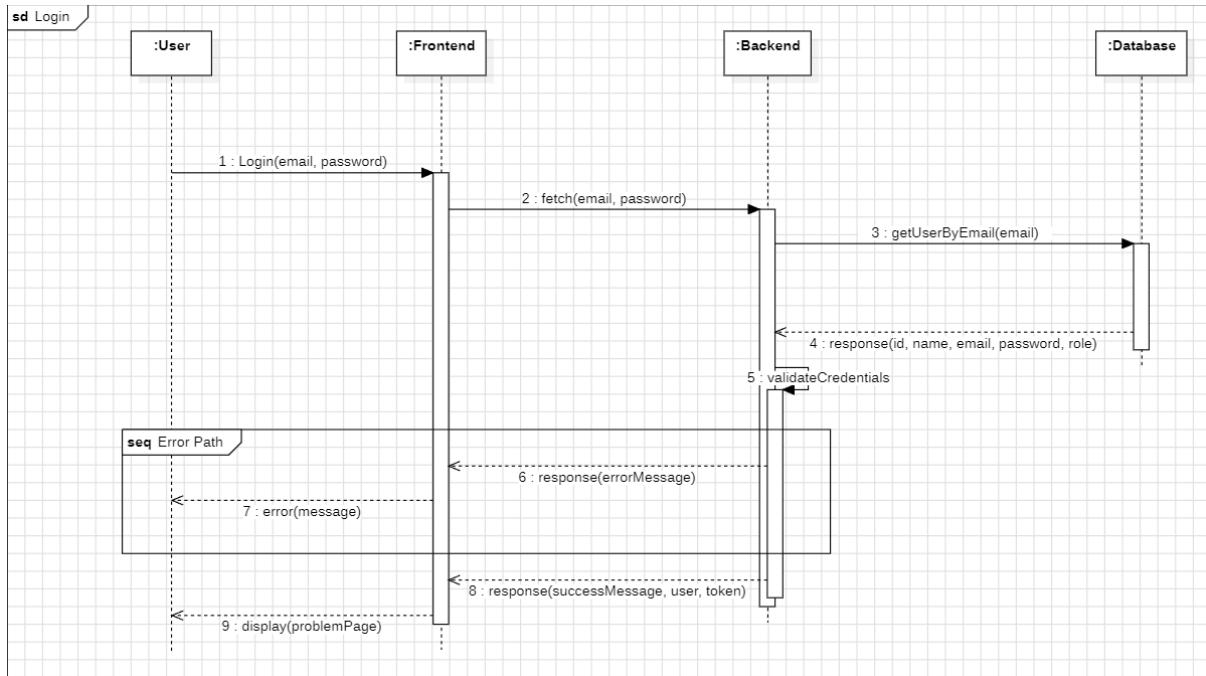


Figure 3. Login sequence diagram

Sign Up

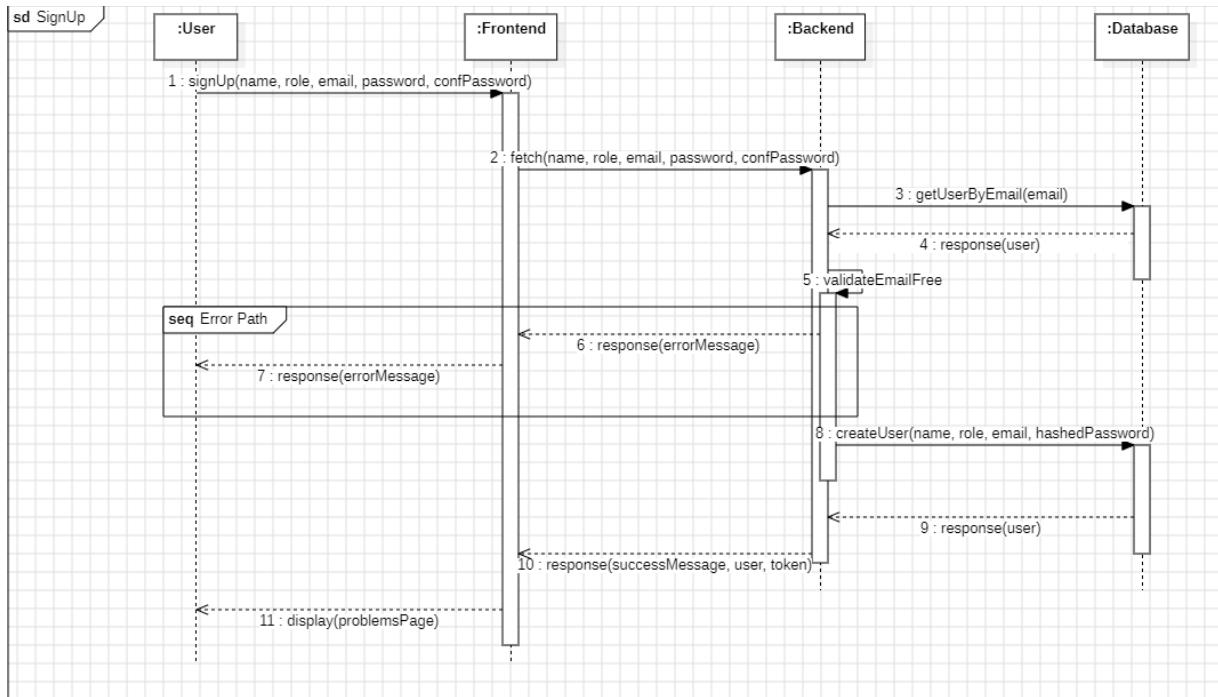


Figure 4. Sign Up sequence diagram

View Problems

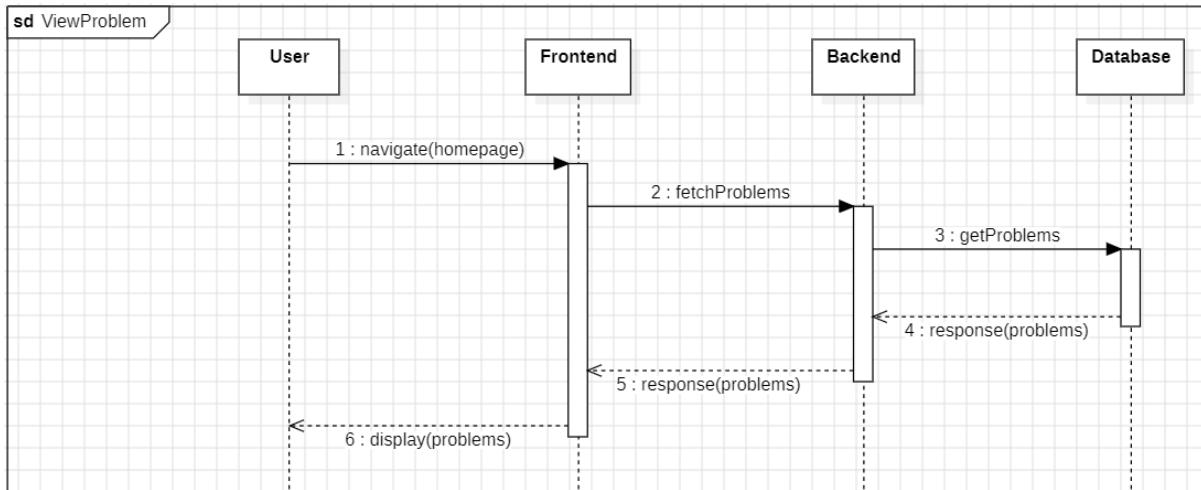


Figure 5. View Problems sequence diagram

Create Problem / Test Cases

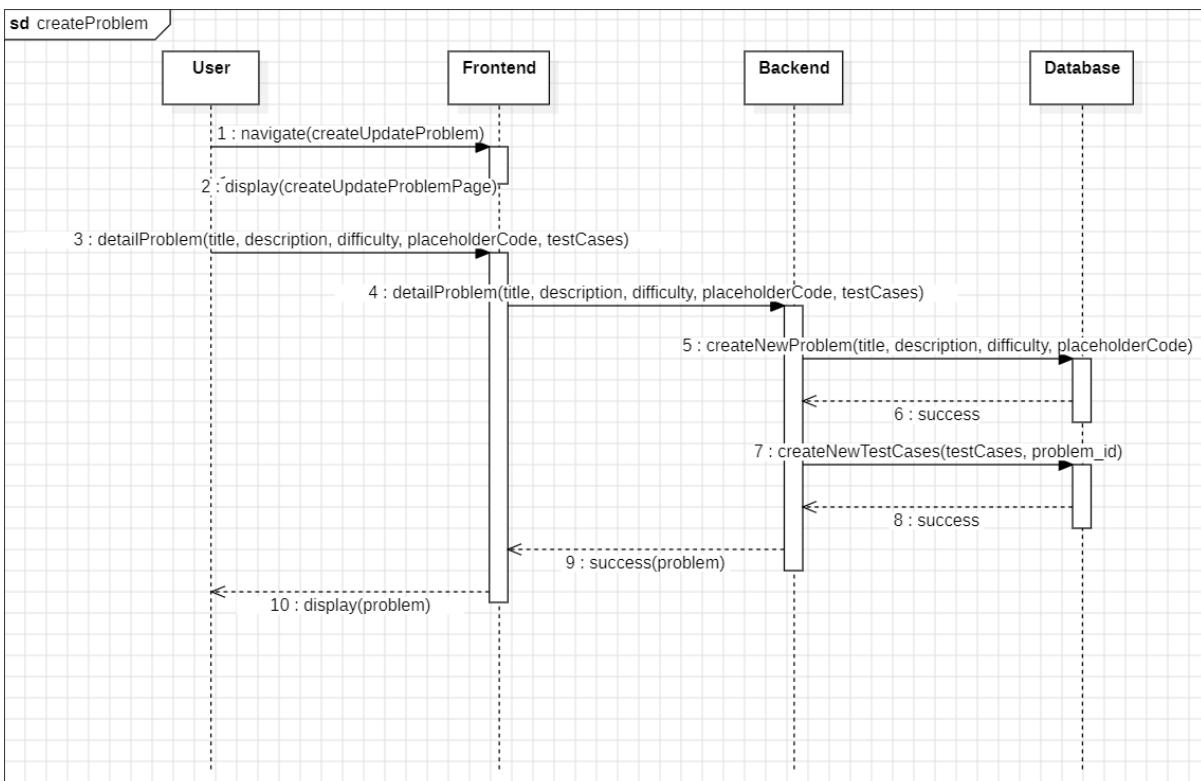


Figure 6. Create Problem / Test Cases sequence diagram

Update Problem / Test Cases

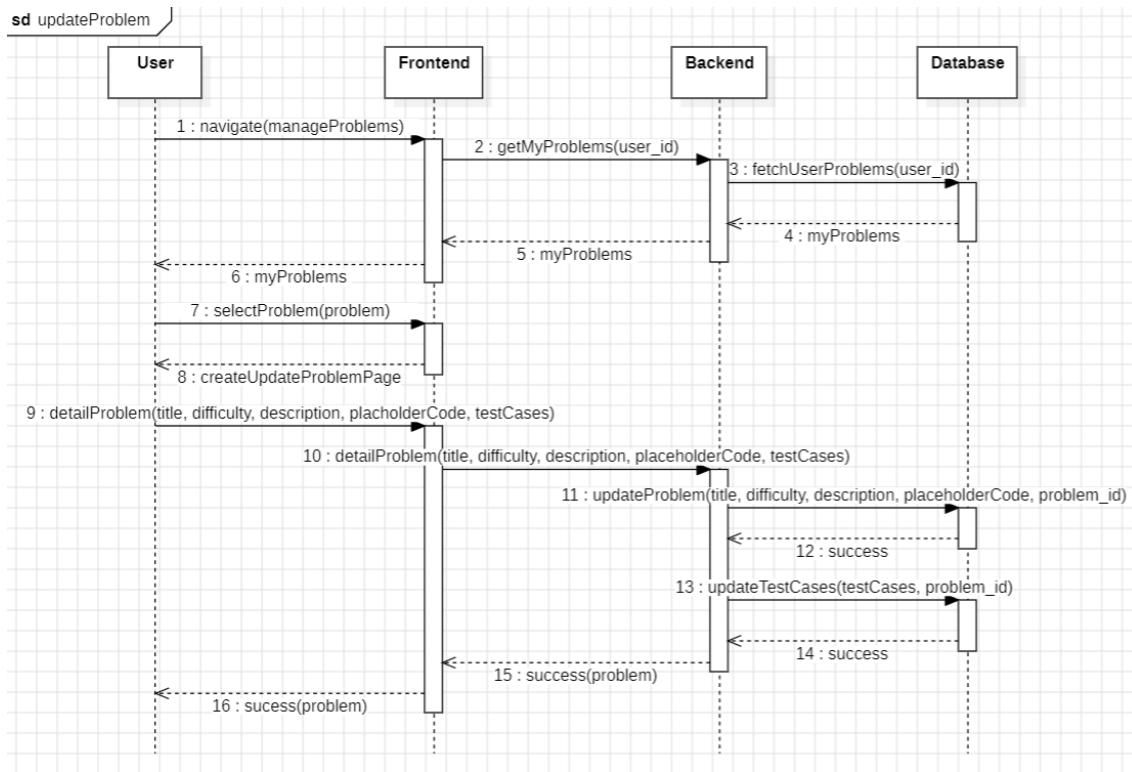


Figure 7. Update Problem / Test Cases sequence diagram

Create / Update Course

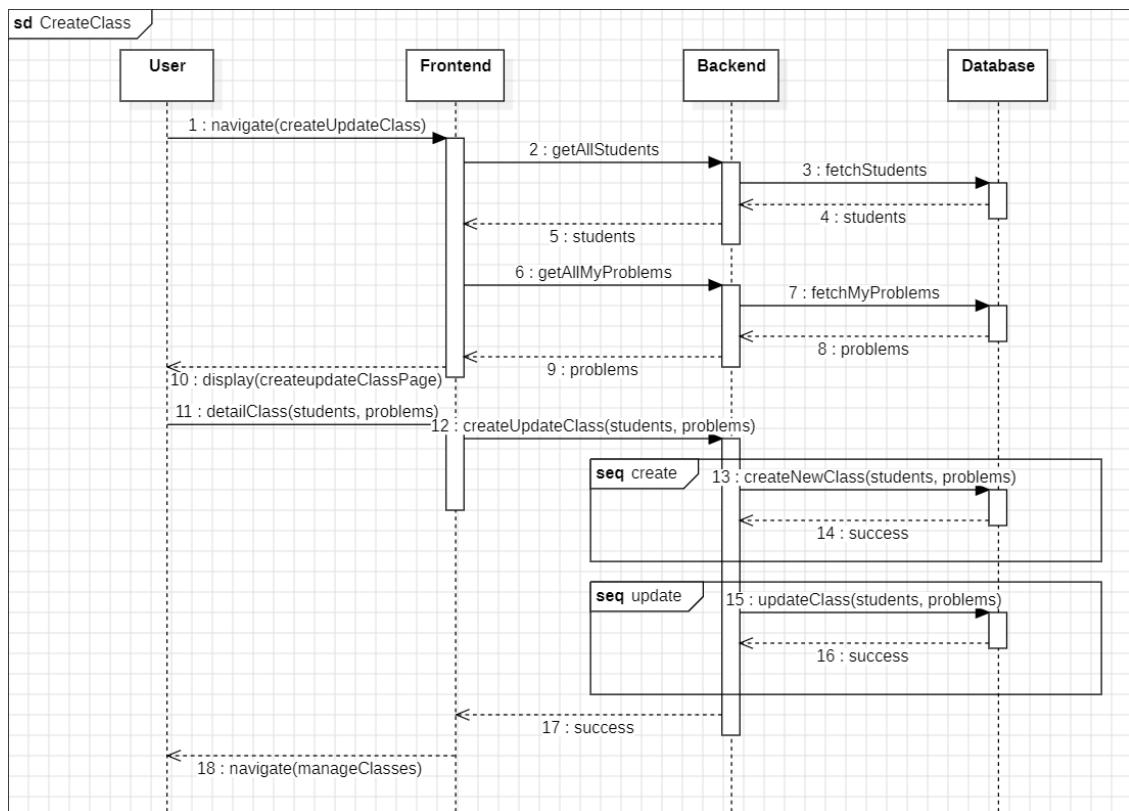


Figure 8. Create / Update Course sequence diagram

View Results

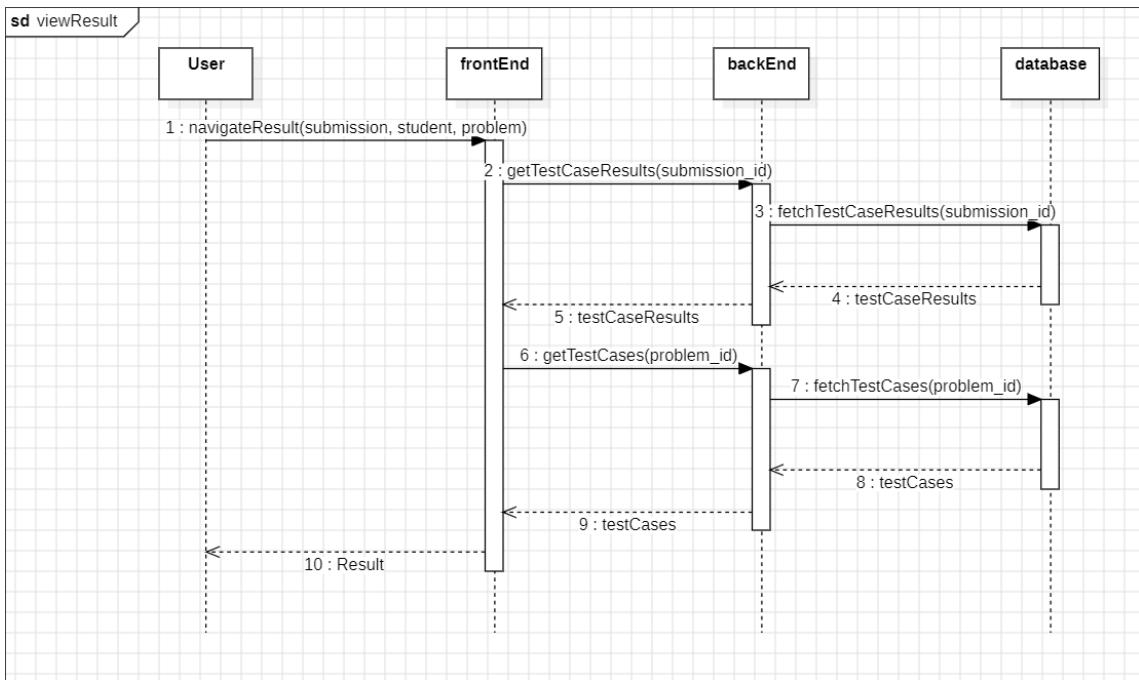


Figure 9. View Results sequence diagram

View Profile

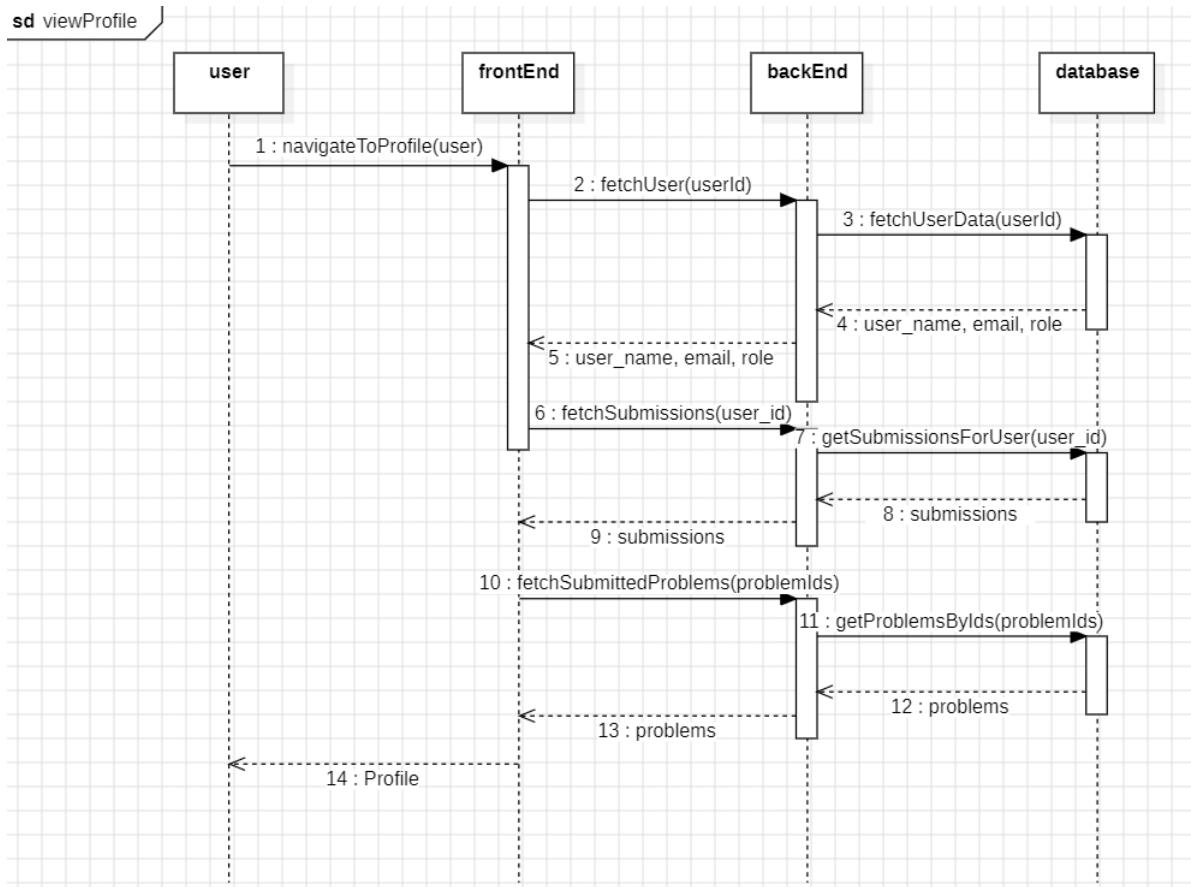


Figure 10. View Profile sequence diagram

[View Leaderboard](#)

Algorithms

Test Harness for Running Submitted Code

To run student submitted functions they must be injected into a static string harness which contains a main class and the needed dependency imports to map sample inputs to function parameters. This allows any inputted java function to run in isolation in a docker container with sample inputs from associated test cases. This harness is mostly the same for all submissions; however, some parts need to be dynamic to allow functions with parameters of different primitive and complex types and functions with different numbers of parameters to run. The harness looks like this:

```
const processedCode = `
import com.fasterxml.jackson.databind.ObjectMapper;
import java.util.*;

public class Main {
    static final ObjectMapper mapper = new ObjectMapper();
    ${code}
    static class Input {
        ${inputFields}
    }
    public static void main(String[] args) {
        try {
            Input input = mapper.readValue(args[0], Input.class);
            ${functionCallLine}
            System.out.println(mapper.writeValueAsString(result));
        } catch (Exception e) {
            System.out.println("ERROR:" + e.getMessage());
        }
    }
}`;
`;
```

Figure 11. Test Harness code

`${code}` is the student's submitted code, `${inputFields}` are all the input parameter types and names, and `${functionCallLine}` contains the final return type, the function itself and the input parameters. “`Input input = mapper.readValue(args[0], Input.class);`” maps sample inputs from problem test cases, these are passed as arguments when the main function is called. Below are the commands that run inside the docker container which allow the java code to execute with test case inputs (`${processedInput}` is the test case inputs).

```
Cmd: ["sh", "-c",
cat << 'EOF' > Main.java
${preprocessedCode}
EOF
javac Main.java
java -cp ".:/app/*" Main '${processedInput}'
```

Figure 12. Commands that run student code inside of docker container

Approach to the use of Artificial Intelligence

It is likely that some students using SETU Code Lab will attempt to use generative AI to assist them with completing problems. This is not how the platform is intended to be used as it hinders students' ability to learn coding concepts effectively. While it is impossible to prevent the use of generative AI entirely, the platform aims to increase the work factor to discourage most users from using it. A file called antiCheat.ts has been created which disables copy/paste functionality and can detect when a user switches tabs. This is only active on the “solve a problem” screen and can be bypassed in certain situations. This only acts as a deterrent to the use of AI assistance.

```
export const useAntiCheat = () => {
  const [shouldAutoSubmit, setShouldAutoSubmit] = useState(false);
  useEffect(() => {
    const prevent = (e: Event) => e.preventDefault();
    const preventContext = (e: MouseEvent) => e.preventDefault();
    const handleKeyDown = (e: KeyboardEvent) => {
      if ((e.ctrlKey || e.metaKey) && ["c", "v", "x", "a"].includes(e.key.toLowerCase())) {
        e.preventDefault();
        alert("Warning: Copy/Paste is disabled");
      }
    };

    const handleVisibility = () => {
      if (document.hidden) {
        setShouldAutoSubmit(true);
        alert("You left the tab. Your work has been automatically submitted.");
      }
    }

    document.addEventListener("visibilitychange", handleVisibility);
    document.addEventListener("copy", prevent);
    document.addEventListener("paste", prevent);
    document.addEventListener("cut", prevent);
    document.addEventListener("contextmenu", preventContext);
    document.addEventListener("keydown", handleKeyDown);
    return () => {
      document.removeEventListener("visibilitychange", handleVisibility);
      document.removeEventListener("copy", prevent);
      document.removeEventListener("paste", prevent);
      document.removeEventListener("cut", prevent);
      document.removeEventListener("contextmenu", preventContext);
      document.removeEventListener("keydown", handleKeyDown);
    };
  }, []);
  return { shouldAutoSubmit }
};
```

Figure 13. AntiCheat.ts file to deter users from using generative AI

Database

Entity Relationship Diagram

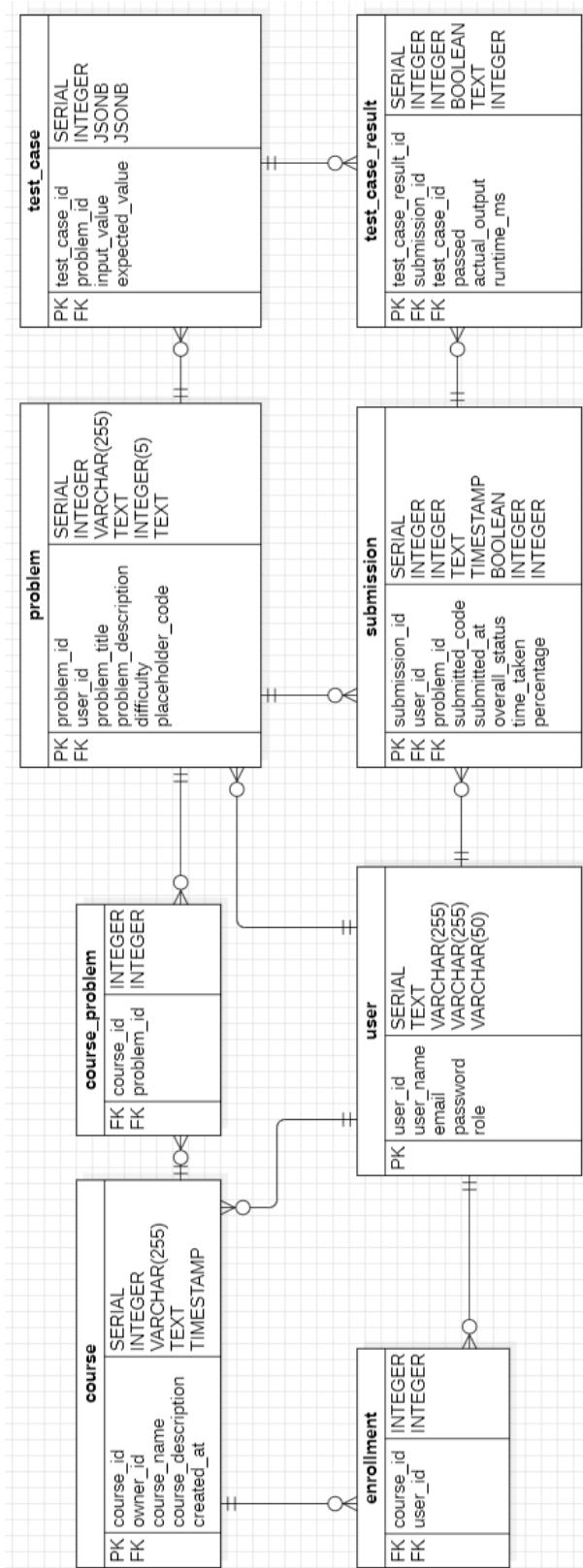


Figure 14. Entity Relationship diagram

SQL Statements

Table Creation

Problem Table

```
CREATE TABLE problem (
    problem_id      SERIAL PRIMARY KEY,
    user_id         INTEGER REFERENCES users(user_id),
    problem_title   VARCHAR(255),
    problem_description TEXT,
    difficulty      INTEGER CHECK (difficulty BETWEEN 1 AND 5),
    placeholder_code TEXT
);
```

Test_case Table

```
CREATE TABLE test_case (
    test_case_id    SERIAL PRIMARY KEY,
    problem_id      INT REFERENCES problem(problem_id) ON DELETE CASCADE,
    input_value     JSONB NOT NULL,
    expected_value  JSONB NOT NULL
);
```

User Table

```
CREATE TABLE users (
    user_id         SERIAL PRIMARY KEY,
    user_name       TEXT NOT NULL,
    email           VARCHAR(255) UNIQUE NOT NULL,
    password        VARCHAR(255) NOT NULL,
    role            VARCHAR(50) NOT NULL CHECK (role IN ('student','lecturer'))
);
```

Submission Table

```
CREATE TABLE submission (
    submission_id   SERIAL PRIMARY KEY,
    user_id         INT REFERENCES users(user_id),
    problem_id      INT REFERENCES problem(problem_id) ON DELETE CASCADE,
    submitted_code  TEXT,
    submitted_at    TIMESTAMP DEFAULT now(),
    overall_status  BOOLEAN,
    time_taken      INT,
    percentage      INT
);
```

Test_case_result Table

```
CREATE TABLE test_case_result (
    test_case_result_id  SERIAL PRIMARY KEY,
    submission_id        INT REFERENCES submission(submission_id) ON
DELETE CASCADE,
    test_case_id          INT REFERENCES test_case(test_case_id) ON
DELETE CASCADE,
    passed                BOOLEAN,
    actual_output          TEXT,
    runtime_ms             INTEGER
);
```

Course Table

```
CREATE TABLE course (
    course_id            SERIAL PRIMARY KEY,
    owner_id              INT REFERENCES users(user_id) ON DELETE
CASCADE,
    course_title          VARCHAR(255),
    course_description    TEXT,
    created_at            TIMESTAMP DEFAULT now()
);
```

Enrollment Table

```
CREATE TABLE enrollment (
    course_id             INT REFERENCES course(course_id) ON DELETE
CASCADE,
    user_id                INT REFERENCES users(user_id) ON DELETE
CASCADE,
    PRIMARY KEY (course_id, user_id)
);
```

Course_problem Table

```
CREATE TABLE course_problem (
    course_id              INT REFERENCES course(course_id) ON DELETE
CASCADE,
    problem_id             INT REFERENCES problem(problem_id) ON
DELETE CASCADE,
    PRIMARY KEY (course_id, problem_id)
);
```

Login/SignUp

createUser SQL Statement

```
INSERT INTO users (user_name, role, email, password)
VALUES ($1, $2, $3, $4)
RETURNING *
```

getUserByEmail SQL Statement

```
SELECT user_id
AS id, user_name
AS name, email, password, role
FROM users
WHERE email = $1
```

View Problems

fetchProblems SQL Statement

```
SELECT problem.*, users.user_name
FROM problem
AS problem
JOIN users AS users
ON problem.user_id = users.user_id
```

Solve Problem

fetchTestCases SQL Statement

```
SELECT *
FROM test_case
WHERE problem_id=$1
```

createSubmission SQL Statement

```
INSERT INTO submission (user_id, problem_id, submitted_code,
overall_status, time_taken)
VALUES ($1, $2, $3, $4, $5)
RETURNING *
```

createTestCaseResult SQL Statement

```
INSERT INTO test_case_result (submission_id, test_case_id, passed,
actual_output, runtime_ms)
VALUES ($1, $2, $3, $4, $5)
```

CRUD Problem

insertProblem SQL Statement

```
INSERT INTO problem (user_Id, problem_title, problem_description,
difficulty, placeholder_code)
VALUES ($1, $2, $3, $4, $5)
RETURNING *
```

fetchProblemsByUserId SQL Statement

```
SELECT problem.*, users.user_name
FROM problem AS problem
JOIN users AS users
ON problem.user_id = users.user_id
WHERE problem.user_id = $1
```

getAllAvailableProblems SQL Statement

```
SELECT * FROM problem
WHERE user_id = $1 OR user_id = 1
```

updateProblem SQL Statement

```
UPDATE problem
SET problem_title=$1, problem_description=$2, difficulty=$3,
placeholder_code=$4
WHERE problem_id=$5 RETURNING *
```

deleteProblem SQL Statement

```
DELETE FROM problem WHERE problem_id=$1
RETURNING *
```

CRUD Test Case

createTestCase SQL Statement

```
INSERT INTO test_case (problem_id, input_value, expected_value)
VALUES ($1, $2::json, $3::json)
RETURNING *
```

updateTestCase SQL Statement

```
UPDATE test_case
SET input_value=$1, expected_value=$2
WHERE test_case_id=$3
RETURNING *
```

deleteTestCase SQL Statement

```
DELETE FROM test_case  
    WHERE test_case_id=$1  
    RETURNING *
```

CRUD Course

fetchAllStudents SQL Statement

```
SELECT user_id AS student_id, user_name AS student_name  
    FROM users  
    WHERE role='student'
```

AddUserToCourse SQL Statement

```
INSERT INTO enrollment (course_id, user_id)  
    VALUES (1, $1)  
    RETURNING *
```

fetchCourseByUserId SQL Statement

```
SELECT c.*  
    FROM course c  
    JOIN enrollment e ON c.course_id = e.course_id  
    WHERE e.user_id = $1
```

fetchCreatedCourseByUserId

```
SELECT * FROM course WHERE owner_id=$1
```

insertCourse SQL Statement

```
INSERT INTO course (owner_id, course_title, course_description)  
    VALUES ($1, $2, $3)  
    RETURNING *
```

insertCourseProblem SQL Statement

```
INSERT INTO course_problem (course_id, problem_id)  
    VALUES ($1, $2) RETURNING *
```

insertEnrollment SQL Statement

```
INSERT INTO enrollment (course_id, user_id)  
    VALUES ($1, $2) RETURNING *
```

updateCourseDetails SQL Statement

```
UPDATE course SET course_title=$1, course_description=$2  
WHERE course_id=$3 RETURNING *
```

deleteCourseProblems SQL Statement

```
DELETE FROM course_problem WHERE course_id=$1
```

deleteEnrollmentsByCourseId SQL Statement

```
DELETE FROM enrollment WHERE course_id=$1
```

fetchProblemIdsFromCourse SQL Statement

```
SELECT problem_id FROM course_problem WHERE course_id = $1
```

fetchStudentIdsFromCourse SQL Statement

```
SELECT user_id FROM enrollment WHERE course_id = $1
```

View Results**fetchStudentsOnCourse SQL Statement**

```
SELECT u.user_id, u.user_name FROM users u  
JOIN enrollment e ON u.user_id = e.user_id  
WHERE e.course_id = $1
```

getSubmissionsForCourse SQL Statement

```
SELECT DISTINCT ON (s.user_id, s.problem_id)  
    s.submission_id,  
    s.user_id,  
    s.problem_id,  
    ssubmitted_code,  
    ssubmitted_at,  
    soverall_status,  
    stime_taken,  
    spercentage  
FROM submission s  
WHERE s.user_id = ANY($1)  
    AND s.problem_id = ANY($2)  
    AND ssubmitted_at > $3::timestamp  
ORDER BY  
    s.user_id,  
    s.problem_id,  
    ssubmitted_at DESC
```

fetchTestCaseResults SQL Statement

```
SELECT * FROM test_case_result WHERE submission_id=$1
```

[View Profile](#)

fetchUserData SQL Statement

```
SELECT user_id, user_name, email, role FROM users  
WHERE user_id = $1
```

deleteAccount SQL Statement

```
DELETE FROM users WHERE user_id = $1
```

getSubmissionsForUser SQL Statement

```
SELECT * FROM submission  
WHERE user_id = $1  
ORDER BY submitted_at DESC
```

getProblemsByIds SQL Statement

```
SELECT * FROM problem WHERE problem_id=ANY($1::int[])
```

User Interface

Logo

This is the logo and favicon for SETU Code Lab. It has been designed in the shape of the letter C and is intended to be simple and recognizable. The light grey and bright red colours have been chosen as they contrast well with the dark background chosen for the rest of the platform.



Figure 15. Logo

High-Level UI Flow

The diagram below shows how to navigate to each screen on the platform. Additional UI elements such as pop-ups and drop-down menus are not shown here, just the main screens. Items in the lecturer only box are only accessible to users with the lecturer role.

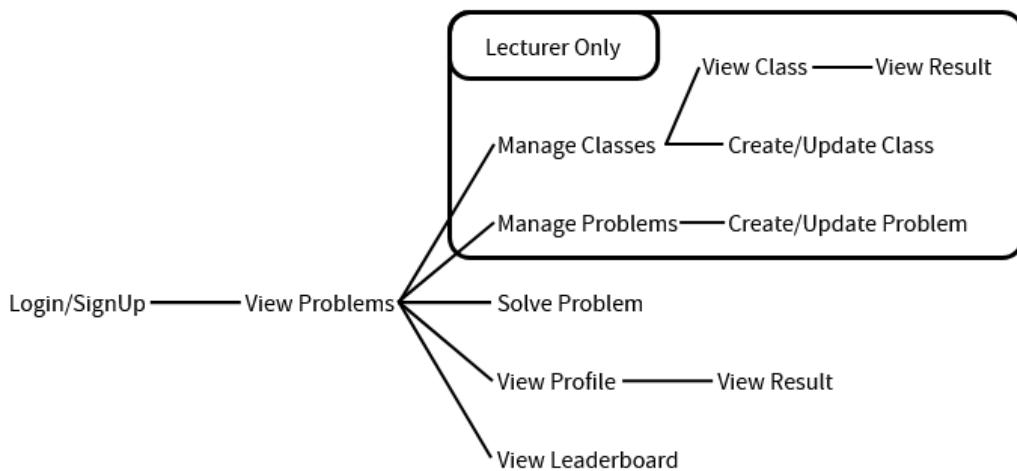


Figure 16. User Interface flow diagram

Login

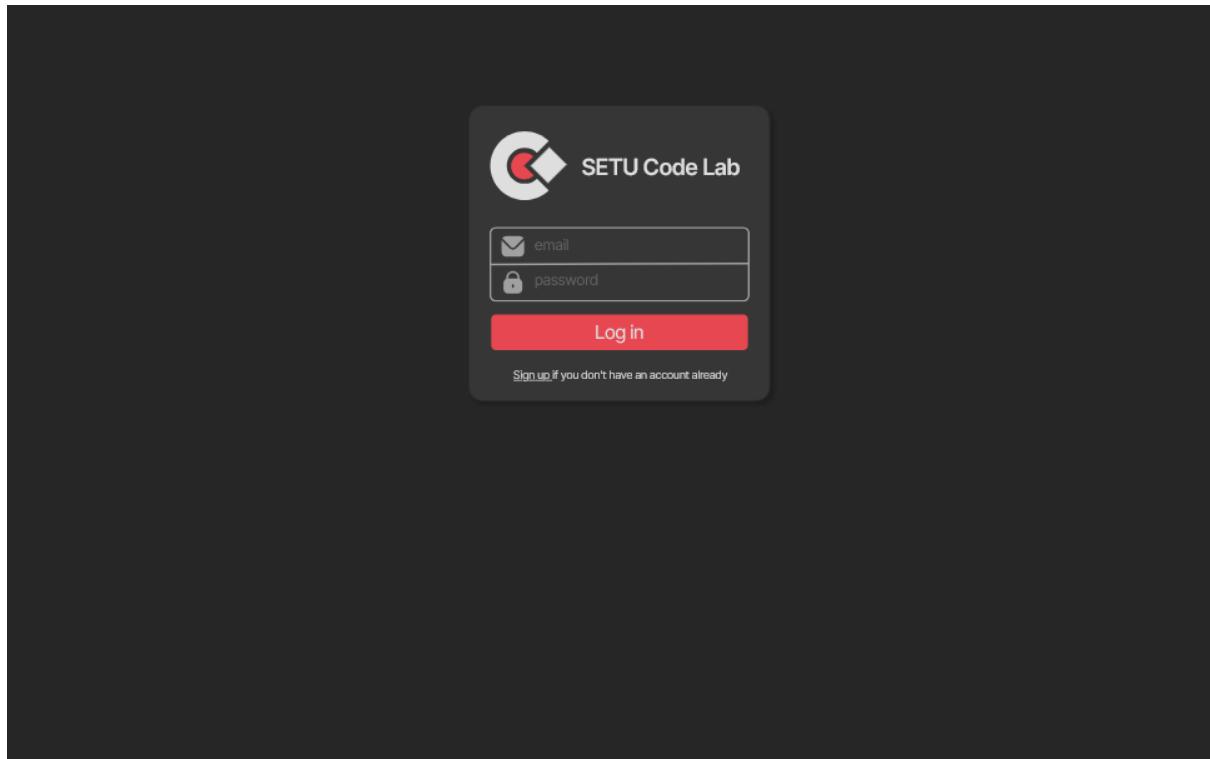


Figure 17. Login screen design

Sign Up

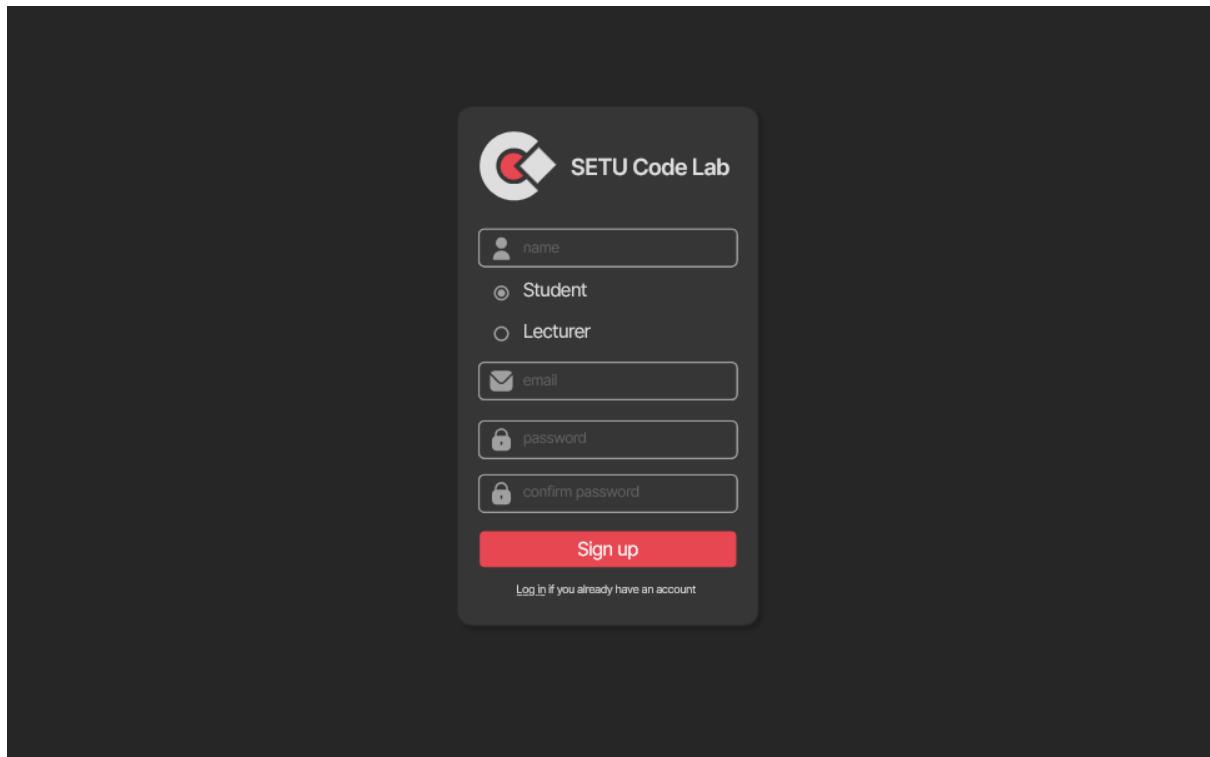


Figure 18. Sign Up screen design

View Problems

The screenshot shows the 'View Problems' section of the SETU Code Lab platform. At the top, there's a navigation bar with links for 'Leaderboard', 'Problems', and 'Profile'. On the right, there's a 'Log Out' button. Below the navigation, a search bar contains the placeholder 'Search Questions...'. A dropdown menu is open, showing 'Courses' and 'Lecturer Menu'. The main content area displays a list of 11 problems, each with a title, author, and a star rating. The problems are:

- 1. Two Sum | Dr. John Doe (5 stars)
- ✓ 2. Wildcard Matching | Dr. Jane Doe (5 stars)
- ✓ 3. Add Two Numbers | Dr. Jane Doe (4 stars)
- 4. Median of Two Sorted Arrays | Dr. Jane Doe (4 stars)
- 5. Remove Element | Dr. Jane Doe (4 stars)
- 6. Two Sum | Dr. John Doe (4 stars)
- 7. Two Sum | Dr. John Doe (4 stars)
- 8. Two Sum | Dr. John Doe (4 stars)
- 9. Two Sum | Dr. John Doe (4 stars)
- 10. Two Sum | Dr. John Doe (4 stars)
- 11. Two Sum | Dr. John Doe (4 stars)

Figure 19. View Problems screen design

View Problem > Solve Problem

This screenshot shows the 'Solve a Problem' interface for the 'Two Sum' problem. The left panel contains the problem statement and examples, while the right panel contains a code editor and test cases.

Problem Statement:

Given an array of integers `nums` and an integer `target`, return indices of the two numbers such that they add up to `target`.

You may assume that each input would have exactly one solution, and you may not use the same element twice.

You can return the answer in any order.

Example 1:
Input: `nums = [2,7,11,15]`, `target = 9`
Output: `[0,1]`
Explanation: Because `nums[0] + nums[1] == 9`, we return `[0, 1]`.

Example 2:
Input: `nums = [3,2,4]`, `target = 6`
Output: `[1,2]`

Example 3:
Input: `nums = [3,3]`, `target = 6`
Output: `[0,1]`

Constraints:

```
2 <= nums.length <= 104
-109 <= nums[i] <= 109
-109 <= target <= 109
Only one valid answer exists.
```

Follow-up: Can you come up with an algorithm that is less than $O(n^2)$ time complexity?

Code Editor:

```
1 class Solution {
2     public int[] twoSum(int[] nums, int target) {
3
4     }
5 }
```

Test Cases:

```
1 [2,7,11,15]
2 9
3 [3,2,4]
4 6
5 [3,3]
6 6
```

Figure 20. Solve a Problem screen design

View Problem > Solve Problem >Submission Alert

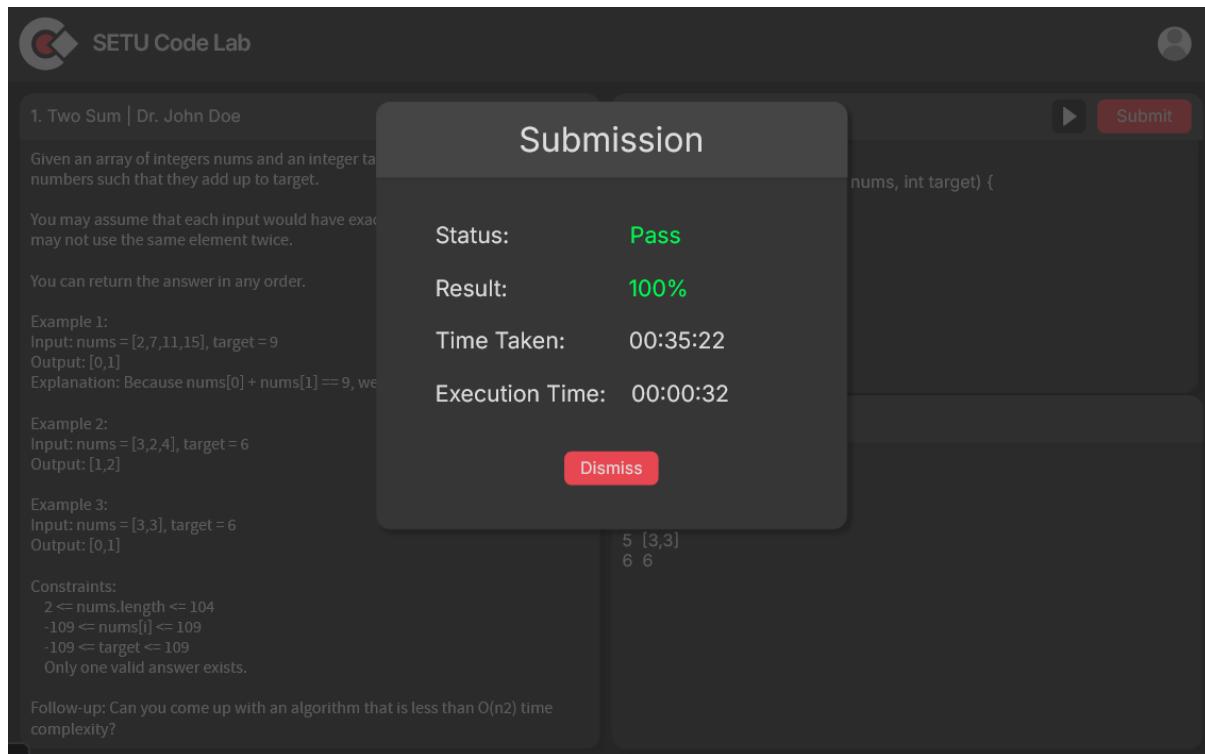


Figure 21. Submission alert design

View Problem > Manage Problems

The screenshot shows a dark-themed "Manage Problems" screen. On the left, there are dropdown menus for "Courses" and "Lecturer Menu". The main content area lists four problems: "1. Two Sum | Y2 SWD", "2. Palindrome Number | Y2 SWD", "3. Remove Element | Y3 GD", and "4. Median of Two Sorted Arrays | All Students". Each problem entry includes a star rating, edit, and delete icon. At the bottom left, there's a button labeled "+ Create New Problem".

Figure 22. Manage Problems screen design

View Problem > Manage Problems > Create/Update Problem

The screenshot shows the 'Create New Problem' section of the application. It includes fields for Title (e.g., Palindrome Number...), Difficulty (e.g., 0-5...), and a large Description area. The Description area contains sample code for checking if a number is a palindrome, followed by Example 1 input (x = 121) and output (true). There is also an 'Explanation' section. To the right, there is a 'Placeholder Code' section with a sample code template and fields for Sample input (e.g., ("x": 313)) and Expected output (eg. true). A 'Next' button is located at the bottom right.

Figure 23. Create / Update Problem screen design

View Problem > Manage Courses

The screenshot shows the 'Manage Courses' section of the application. It lists four courses: 1. Y3 Software Development, 2. Y2 Games Development, 3. Y1 Common, and 4. All Students. Each course entry has edit and delete icons. A 'Create New Class' button is located at the bottom left.

Figure 24. Manage Courses screen design

View Problem > Manage Courses > Create/Update Course

The screenshot shows a dark-themed web application interface for managing courses. At the top left is the 'SETU Code Lab' logo. To its right are links for 'Leaderboard | Problems | Profile'. On the far right is a user icon. The main area has a header 'Create New Class'. Below it is a 'Title:' input field containing 'eg. Y3 Software Development...'. There are two sections of buttons: 'Add Problem' and 'Add Student'. The 'Add Problem' section contains four items: '1. Two Sum', '2. Palindrome Number', '3. Remove Element', and '4. Median of Two Sorted Arrays'. The 'Add Student' section contains four student names: '1. Stuart Rossiter', '2. Diarmuid O'Neill', '3. Conor Hendley', and '4. Isaiah Andres'. A red 'Next' button is located at the bottom right.

Figure 25. Create / Update Course screen design

View Problem > Manage Courses > View Course

The screenshot shows a dark-themed web application interface for viewing course results. At the top left is the 'SETU Code Lab' logo. To its right are links for 'Leaderboard | Problems | Profile'. On the far right is a user icon. The main area has a header 'SWD Y3 - Student Results'. Below it is a table showing student performance across four problems. The columns are labeled '1. Two Sum', '2. Palindrome Number', '3. Remove element', '4. Median of Two Sorted Arrays', and 'Total'. The rows represent four students: Stuart Rossiter, Diarmuid O'Neill, Conor Hendley, and Isaiah Andres. Each row shows their percentage completion for each problem and a total percentage. A red 'Download Results.csv' button is located at the bottom right.

	1. Two Sum	2. Palindrome Number	3. Remove element	4. Median of Two Sorted Arrays	Total
1. Stuart Rossiter	100%	-	100%	-	-
2. Diarmuid O'Neill	40%	80%	39%	33%	48%
3. Conor Hendley	100%	100%	99%	100%	100%
4. Isaiah Andres	100%	100%	100%	100%	100%

Figure 26. View Course screen design

View Problem > Manage Course > View Course > View Result

The screenshot shows the 'View Result' screen for a student named Isaiah Andres. The top navigation bar includes links for Leaderboard, Problems, and Profile. The main content area is divided into two sections: 'Isaiah Andres - Palindrome Number Submission' and 'Test Case Results'. The submission details include: Submitted: Feb 15th, 2026 18:56, Overall Status: Pass, Time Taken: 01:01:21, and Submitted Code:

```
public static boolean isPalindrome(int x) {
    if(x<0) {
        return false;
    }
    int forwards = x;
    int temp = 0;
    while(forwards != 0) {
        temp = temp * 10;
        temp += forwards % 10;
        forwards = (forwards / 10);
    }
    return temp == x
}
```

The 'Test Case Results' section displays four successful test cases, each showing Input: {"x":121}, Expected Output: true, Actual Output: true, Result: Pass, and Runtime: 52ms.

Figure 27. View Result Screen design

View Problem > Profile

The screenshot shows the 'View Profile' screen for a student named Diarmuid O'Neill. The top navigation bar includes links for Leaderboard, Problems, and Profile. The left sidebar shows course and lecturer menu options. The main content area is divided into two sections: 'Profile' and 'Submission History'.

In the 'Profile' section, the student's profile picture is shown, along with the name Diarmuid O'Neill and the title Student. Below this, statistics are listed: Problems completed: 24, Longest Streak: 3, and Rank: GOLD. A red 'Delete Account' button is also present.

The 'Submission History' section lists 11 recent submissions, each with the problem name, overall status, and submission date:

Problem	Overall Status	Submitted at
1. Two Sum	Pass	Feb 15th, 2026 18:56
2. Palindrome Number	Pass	Feb 14th, 2026 19:23
3. Remove element	Fail	Feb 14th, 2026 18:03
4. Median of Two Sorted Arrays	Fail	Feb 10th, 2026 17:52
5. Two Sum	Pass	Feb 9th, 2026 18:56
6. Palindrome Number	Pass	Feb 7th, 2026 19:23
7. Remove element	Fail	Feb 2th, 2026 18:03
8. Median of Two Sorted Arrays	Fail	Jan 21th, 2026 17:52
9. Palindrome Number	Pass	Jan 14th, 2026 19:23
10. Remove element	Fail	Jan 12th, 2026 18:03
11. Median of Two Sorted Arrays	Fail	Jan 1th, 2026 17:52

Figure 28. View Profile screen design

[View Problem](#) > [Leaderboard](#)

Automated Deployment Script

The following script automates the deployment process. It works by pulling any code changes from the remote GitHub repository, running the frontend build step, running the backend build step and finally restarting the backend application.

```
#!/usr/bin/env bash

# Exit immediately if a command exits with a non-zero status
set -e

cd /var/www/SETU_Code_Lab || exit 1

git pull

cd /var/www/SETU_Code_Lab/SETU_Code_Lab_Code/client || exit 1

npm run build

cd /var/www/SETU_Code_Lab/SETU_Code_Lab_Code/server || exit 1

npm run build

pm2 restart setucl-backend

echo "Deployment Successful"
```