

BATTLE OF BRAIN ONLINE JUDGE

A Project Report/Thesis is submitted to the
Department of Computer Science and Engineering, Hajee Mohammad Danesh Science and
Technology University in partial fulfillment of the requirements for the degree of
B.Sc. (Engineering) in Computer Science and Engineering

By

Md. Sohel Rana
Student ID: 1602047
Session: 2016

Md. Nazmul Hasan
Student ID: 1602061
Session: 2016

Md. Kaif Ul Alom
Student ID:1602064
Session:2016

Supervised by
Md. Sohrawordi
Assistant Professor



DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY,
DINAJPUR-5200, BANGLADESH

March 2020

Department of Computer Science and Engineering
Faculty of Computer Science and Engineering
Hajee Mohammad Danesh Science and Technology University
Dinajpur-5200, Bangladesh



CERTIFICATE

This is to certify that the work entitled as “**BATTLE OF BRAIN ONLINE JUDGE**” by Md. Sohel Rana, Md. Nazmul Hasan and Md. Kaif Ul Alom has been carried out under our supervision. To the best of our knowledge this work is an original one and was not submitted anywhere for a diploma or a degree.

Co-supervisor

.....

(Hasi Saha)

Assistant Professor

Department of Computer Science and Engineering

Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh

Supervisor

.....

(Md. Sohrwordi)

Assistant Professor

Department of Computer Science and Engineering

Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh

Department of Computer Science and Engineering
Faculty of Computer Science and Engineering
Hajee Mohammad Danesh Science and Technology University
Dinajpur-5200, Bangladesh



DECLARATION

The work entitled “**BATTLE OF BRAIN ONLINE JUDGE**” has been carried out in the Department of Computer Science and Engineering, Hajee Mohammad Danesh Science and Technology University is original and conforms the regulations of this University.

We understand the University’s policy on plagiarism and declare that no part of this thesis has been copied from other sources or been previously submitted elsewhere for the award of any degree or diploma.

.....
(Md. Sohel Rana)
Student ID: 1602047
Session: 2016

.....
(Md. Nazmul Hasan)
Student ID: 1602061
Session: 2016

.....
(Md. Kaif Ul Alom)
Student ID: 1602064
Session: 2016

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Abstract

One of the most important aspects of computer science is programming. Quality of programming depends on the skill of problem solving. An online judge is a platform where participants can find and solve various types of problems using specific programming languages. This is an automatic programming assessment grading system. Online judge will help students to be good in competitive programming, helps them sharpen their logic. This is very good site for self-study. Here every one can learn programming languages, algorithms, data structures and can judge their skills. There are many universities in Bangladesh who have their own online judge. On its continuation last year few students of HSTU developed an online judge named “ByteOJ”. But they put it incomplete. In “ByteOJ” no contest feature is available; there is no training section, no user standings tab, no searching and password recovery feature. This paper describes the design and development of an online based code judging system. Our proposed system name is BATTLE OF BRAIN ONLINE JUDGE. In fact it is the continuity of “ByteOJ”. The goal of this project is to develop a complete online judge which would help the students of HSTU to practice and participate in programming contest. Here Admin can add, modify, delete problems, training resources, contest and block user. The users can sign-up and sign-in to the system. Password recovery features are available for users. The user can read problems and submit their solutions after a valid login process. The users can search problems by specific tag. Also user can filter the problem according to difficult level. On standings page user can filter any user or users from same institution or from same country by putting the user handle, institutions name, country name in search box. Contest arranging features are now available. More interesting features will be added in the future such as code editor, submitted solution downloading feature, user to user texting tools like messaging or live chat and so on.

Chapter 1

Introduction

An online judge is an online system to test programs in programming contests [1]. They are also used to practice for such contests. Judge system can compile and execute your code, and test your code with pre-constructed data [2]. Submitted codes are tested under some conditions such as time limit, memory limit, security issue, restricted languages and so on. The output of system for user given source code is captured and compared with actual output and after comparing the system will return specific verdict [3].

1.1 COMPETITIVE PROGRAMMING

Competitive programming is a mind sport usually held over the Internet or a local network, involving participants trying to program according to provided specifications [4]. Competitive programming is solving well-defined problems by writing computer programs under specified limits or constraints [5]. Programmers can choose any restricted programming languages like Java, Python, C, C++ and so on or only by those programming languages which is permitted by the organizers. It helps programmers to not only build on what they have learnt but learn new programming skills as well. For secondary school students the biggest Competitive Programming competition in the world is International Olympiad in Informatics (IOI). ACM: Association for Computing Machinery organizes the world biggest annual Competitive Programming Contest among the universities of the world which is known as ACM-ICPC [6]. Some other organizations also arranged annual Programming Contest like Facebook, Google, Samsung and so on. In Bangladesh many organizations and Universities host an annual Programming Contest among all other universities of the country which is known as Inter University Programming Contest (IUPC). Also some online judge arranged weekly/monthly Programming Contest for increasing skills of the programmers.

1.2 PROGRAMMING CONTEST

A programming competition generally involves the host presenting a set of logical or mathematical problems to the contestants and contestants are required to write computer programs capable of solving each problem [7]. Contestant can vary in number from tens to several thousands. Judging is based mostly upon number of problems solved, time spent for writing successful solutions, number of unsuccessful verdict. Contests have rank list showing users accepted solutions.

1.3 JUDGING SYSTEM

Judging is done automatically by the host Judging System which is commonly known as online judge. Contest problems have an all-or-none marking system, meaning that a solution is "Accepted" only if it produces satisfactory results on all test cases run by the judge, and otherwise [8]. However in some contest and in some problems may have partial scoring, depending on the number of test cases passed. The judging system show some specific verdict for a particular source code based on the comparison of produced output with actual output.

Some common verdicts [9] regarding to solutions:

- **Accepted:** The solution is correct. It produced the right answer in a reasonable time and within the limit memory usage.
- **Compilation error:** The compiler could not compile the program; it may have a syntax error.
- **Time limit exceeded:** The program hadn't finished execution in time indicated in the problem statement.
- **Memory limit exceeded:** The program tries to consume more memory than is indicated in the problem statement.
- **Stack Overflow/ Runtime Error:** The program terminated with a non-zero return code (possible reasons: array out of bounds error, division by zero, stack overflow, etc).
- **Wrong answer:** Correct solution not reached for the inputs.

There are some security concerns for the online judge such as:

- Some code can execute other processes.
- Some code can look into your file directory, and get some information.
- Some code can run administrative command.
- Some code can consume the server's bandwidth.

1.4 PROPOSED SYSTEM

This proposed system is a project that provides a platform to the programmers, students as well as the software engineering practitioners. All the Programming resources could be found together. Moreover, the focus is on providing a platform for the students to sharpen their skills and make them ready for programming competitions. In this system we are trying to add all required feature such as Sign in, Sign up, Password recovery, Problem set, Standings, Status, Contest, Training features. Where some of those features such as Password recovery, Standings, Contest, Training features are not present in "ByteOJ" [10]. We also add problem filtering, status filtering, conditional coloring options which are also not present in "ByteOJ".

1.5 OBJECTIVES

- To develop an online judge where users can read problems and submit their solutions to check the accuracy.
- To help users sharpen their programming skills.
- Also try to provide programming learning resources where users can learn programming languages, algorithms in Bengali languages.
- To host programming contests.

1.6 WORK OUTLINE

During the development of this project SDLC has been used, System Development Life Cycle among the other models for developing a project. Here is the organized pattern for the project:

Chapter 2 includes the analysis of the situation of the present system for online judges, different present system applications. Chapter 3 includes instruction to the proposed system, advantages, proposed information flow diagram and functional components about the Proposed System. Chapter 4 traces Structured Analysis with tools such as Use case diagram, Class diagram, E-R diagram, Activity diagram, State diagram, and so forth. Chapter 5 includes Implementation and Testing with some snapshots of the proposed System. Chapter 6 describes Conclusion and gives suggestions for further expanding of the proposed system. Chapter 7 includes the references

Chapter 2

Literature Review

Online judges have various types of problems which can be solved by a user at any time. Nowadays in the Internet there are also several online judges which can host programming contest in real time. In real time programming contest users are only able to solve the problems in a given time period. After real time contest contestants can up-solve those problems in most of the online judges.

2.1 CURRENTLY AVAILABLE SYSTEM

2.1.1 UVA

The first online judge system that gained high popularity worldwide is the UVa Online Judge [11]. It was founded in 1995 by Miguel Angel Revilla. It provides an enormous archive of programming challenges originating from the ACM contests. It contains over 4,500 problems for practicing. A user may submit a solution in ANSI C, C++98, Pascal, Java, C++11 or Python. Here specially in October to December programming contest is held for about five hours long.

2.1.2 CODEFORCES

One of the most popular online judges is Codeforces[12]. It organizes contests on a regular basis. It divides participants into three divisions according to their adaptation which is updated for every competition conducted. A single round may takes 2 to 2.5 hours and considers at least five programming challenges. Programmers get color according to their contest rating.

2.1.3 TIMUS

Timus is the Russian archive of programming problems with automatic judging system [13]. Problems are mostly collected from contests held at the Ural Federal University, Ural Championships, ICPC Ural Regional Contests, and Petrozavodsk Training Camps. Contest rules resemble the rules of International Collegiate Programming Contest (ACM ICPC). No additional registration is required for participation in a contest, you may just enter the website when the contest starts and begin to solve problems.

2.1.4 LIGHTOJ

LightOj is the first Bangladeshi online judge [14]. It has over 400 algorithmic problems. Practicing at lightoj is as good for beginners as it is categorized and has also chat room and forum which helps to communicate with other programmers about any problem.

2.1.5 Atcoder

Atcoder is also one of the most popular online judge. It is a Japanese online judge[15]. It also arrange real time contest in a regular basis. Contestants rating can increase or decrease based on their performance.

2.1.6 HACKERRANK

Hackerrank is a technology company that focuses on competitive programming challenges in different domain of Computer Science [16]. Any user can host their contest on Hackerrank with some conditions.

2.1.7 HACKER EARTH

HackerEarth has conducted over 1000 hacathons and over 10,000 programming contest to date [17]. HackerEarth offers programming tutorials and practice problems.

2.1.8 CODECHEF

CodeChef is a competitive programming website. It is maintained by Directi [18]. CodeChef hosts three programming contests every month, in which users can participate and compete for prizes and a standing on the contest leaderboard. The Long Challenge is a ten day long contest featuring 8 questions of varying difficulty. The Long Challenge commences on the first Saturday of each month. The Lunchtime is a contest that was primarily started for school students to hone their programming skills. This 3-hour contest takes place on the last Saturday of every month featuring a set of 4 questions. The third contest is the Cook-Off which takes place on the second-last Sunday of every month and consists of 5 questions to be solved over 3 hour duration.

2.1.9 CODEMARSHAL

CodeMarshal is also a Bangladeshi platform mainly built for real time contests [19]. It provides a contest hosting platform to educational institutions under some conditions. Many Bangladeshi national programming contest evens was successfully hosted in CodeMarshal.

2.1.10 URI

URI Online Judge is also an automatic online judging platform developed in the Computer Science Department at Universidade Regional Integrada, Brazil [20].

2.1.11 TOPCODER

Topcoder is another problem solving platform. Topcoder also arrange real time contest in a regular basis [21]. All the features of online judge is available here.

2.1.12 SOURCECODE

This is also an automatic online judging platform developed in the Computer Science and Engineering Department at Shahjalal University of Science & Technology [22]. This is mainly

developed for the students of SUST. This is a complete online judge where real time contest hosts for the students of SUST.

2.1.13 BYTEOJ

This automatic online judging platform is developed in Computer Science and Engineering Department at Hajee Mohammad Danesh Science and Technology University[23]. This system has Problem and Status feature with sign in, sign up feature. But contest, standings, standing filtering, problem searching by tag – difficulty level, verdict coloring, training, password recovery features are not present in here.

By reviewing all those existing system we have come to conclusion that, we need a fully developed online judge for our own university. Where we can arrange programming contest, see standings of our students, filtering student's standings, we can save and publish those contest problems after finishing the contest for practicing in future, filtering problems by specific tag or difficulty level, learn programming languages – algorithms - data structures and so on. In BATTLE OF BRAIN ONLINE JUDGE we are successfully added all those features.

CHAPTER 3

PROPOSED SYSTEM

We need to develop an online judge for our own institution. So we can host real time programming contests at our convenience. And also that contests and practices can be monitored more concisely.

3.1 REQUIREMENT ANALYSIS

Requirement analysis is significant and essential activity after elicitation. Requirements convey the expectations of users from the software product. The requirements can be obvious or hidden, known or unknown, expected or unexpected from client's point of view. In software engineering, it is sometimes referred to loosely by names such as requirements gathering or requirements capturing. Requirements analysis encompasses those tasks that go into determining the needs or conditions to meet for a new or altered product or project, taking account of the possibly conflicting requirements of the various stakeholders, analyzing, documenting, validating and managing software or system requirements. Requirement analysis helps organizations to determine the actual needs of stakeholders. At the same time, it enables the development team to communicate with stakeholders in a language they understand (like charts, models, flow-charts which are discussed in chapter 4) instead of pages of text. User requirements for an online judge:

- Where user can contact with other programmers.
- Where user can learn programming.
- Where user can participate in real time contest.
- Where user can search problems by specific tag.
- Where user can search and solve problems by difficulty level.
- Where user see different color in different verdict for submission.
- Where user can learn programming languages, algorithms, data structures.
- Where user can compare his/her standings with others.
- Where user can filter standings.
- Where user can get password recovery feature.
- Where user can get clarification of any running contest.
- From where user get notification for upcoming contest.

3.2 DESCRIPTION OF PROPOSED SYSTEM

In our proposed system there can have 3 types of user: admin, logged user and guest user.

Admin can:

- Add, delete, modify a problem.
- Create Contest in real time.
- Edit contest time.
- Delete contest.
- Modify contest.
- Add, delete programming tutorials.
- Also modify tutorial/training section.
- Block any user

Logged User can:

- View a problem.
- Filter problems
- Filter status
- Submit the solution of the problem.
- See the statistics of own submissions.
- See the live submissions.
- See the current Standings.
- Filter standings.
- See different color in different verdict.

Guest user can:

- View a problem.
- See the live submissions.
- See the current Standings.
- See tutorials.
- Filter Standings.
- Filter problems.

3.3 ADVANTAGES OF PROPOSED SYSTEM

- The proposed system helps to monitor the contestant's performance over time.
- It can also help to find out the weak points of the contestants in specific types of problems and help to overcome them.
- The system is also a light and flexible so that contest can be arranged at any given time.
- The system is easily available all the time and maintainable.
- It will tackle all the hassles for arranging contests in other contest sites.
- Experienced contestants can submit their own problems to train the new problem solvers.
- The system can handle a few hundred submissions at a time.
- Beginners can contact via email with experienced contestants.
- Contestants can learn programming tutorials from Bengali resources.
- Programming tutorial's topics are placed from beginning to advance. That will help to choose a topic after another.

3.4 INFORMATION FLOW DIAGRAM

In the information flow diagram, user has entire user information preserved in the database. The database also stores user statistics of solved problems and accuracy etc. When the user submits a problem solution, user data along with the code is processed for judgment. After judgment, user gets the judgment and user profile is updated accordingly.

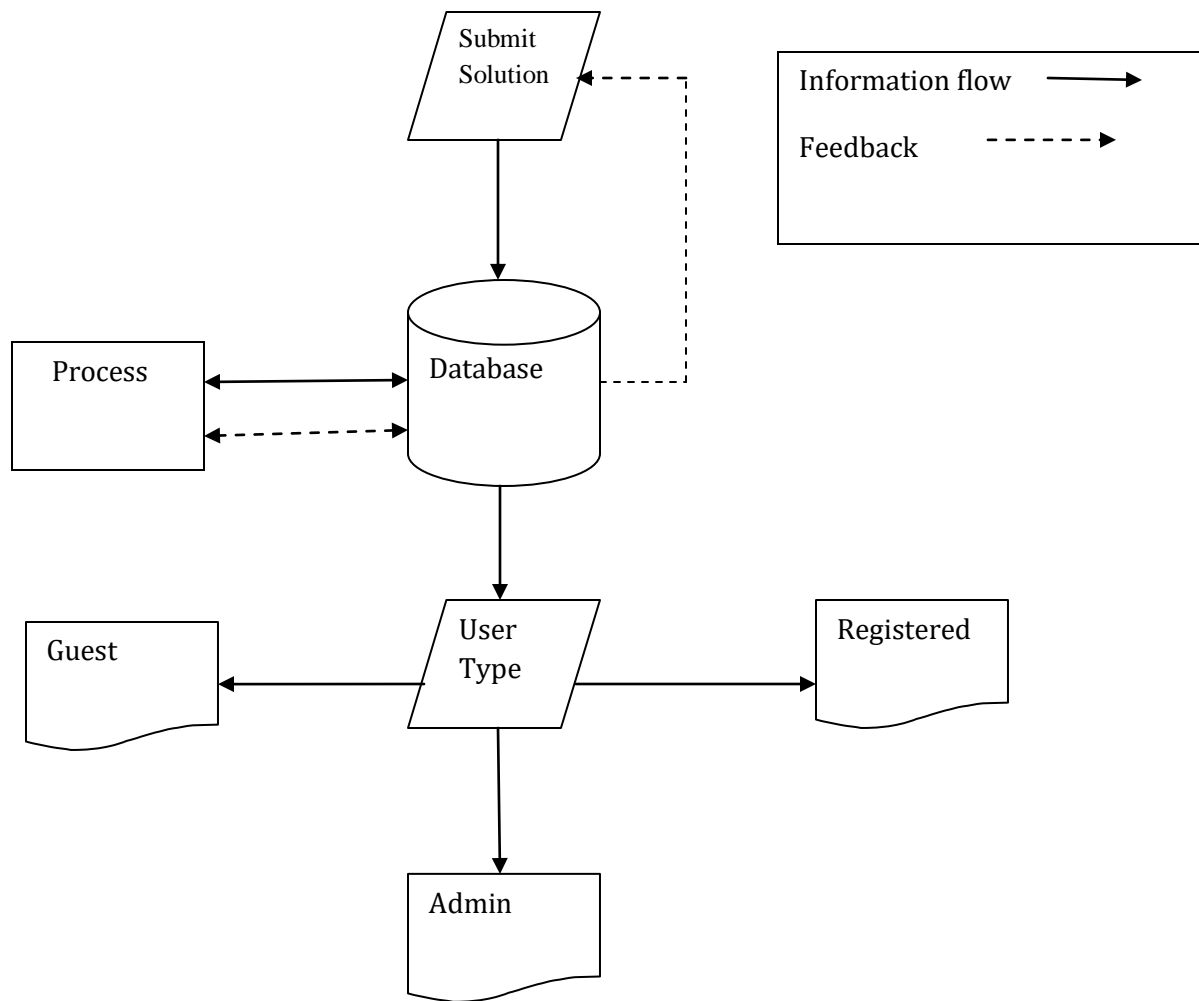


Fig. 3.1. Information Flow Diagram of proposed system.

CHAPTER 4

SYSTEM DESIGN

A system is an orderly grouping of interdependent components linked together according to a plan to achieve a specific goal. System Design is a process of planning a new business system or replacing an existing system by defining its components or modules to satisfy the specific requirements. System Design focuses on how to accomplish the objective of the system. In this chapter, class diagram, use case diagram and other parts are described comprehensively.

4.1 CLASS DIAGRAM

Structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among objects[24]. It is also known as a structural diagram. It represents the static view of an application. Class diagram in UML can be directly mapped with object-oriented languages. Class diagram of this Project: A class diagram in the Unified Modeling Language (UML) is a type of static

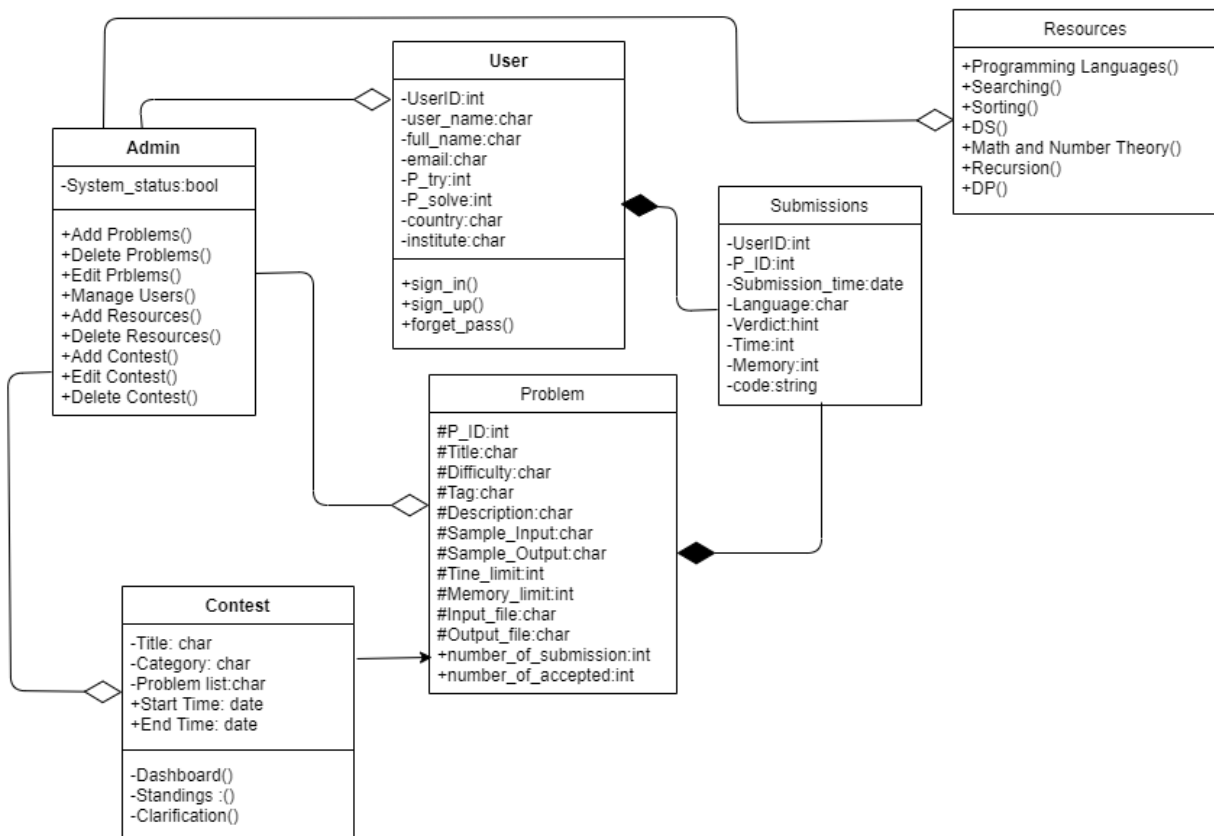


Fig. 4.1. Class Diagram of proposed system

4.2 ENTITY RELATIONSHIP DIAGRAM

An entity relationship diagram (ERD) shows the relationships of entity sets stored in a database [25]. An entity set is a collection identical entities. So, we can say that Entity relationship diagram is the representation of objects in a system through the use of symbols to represent the relationship between one entity or more than one entity set. ER diagram of this project:

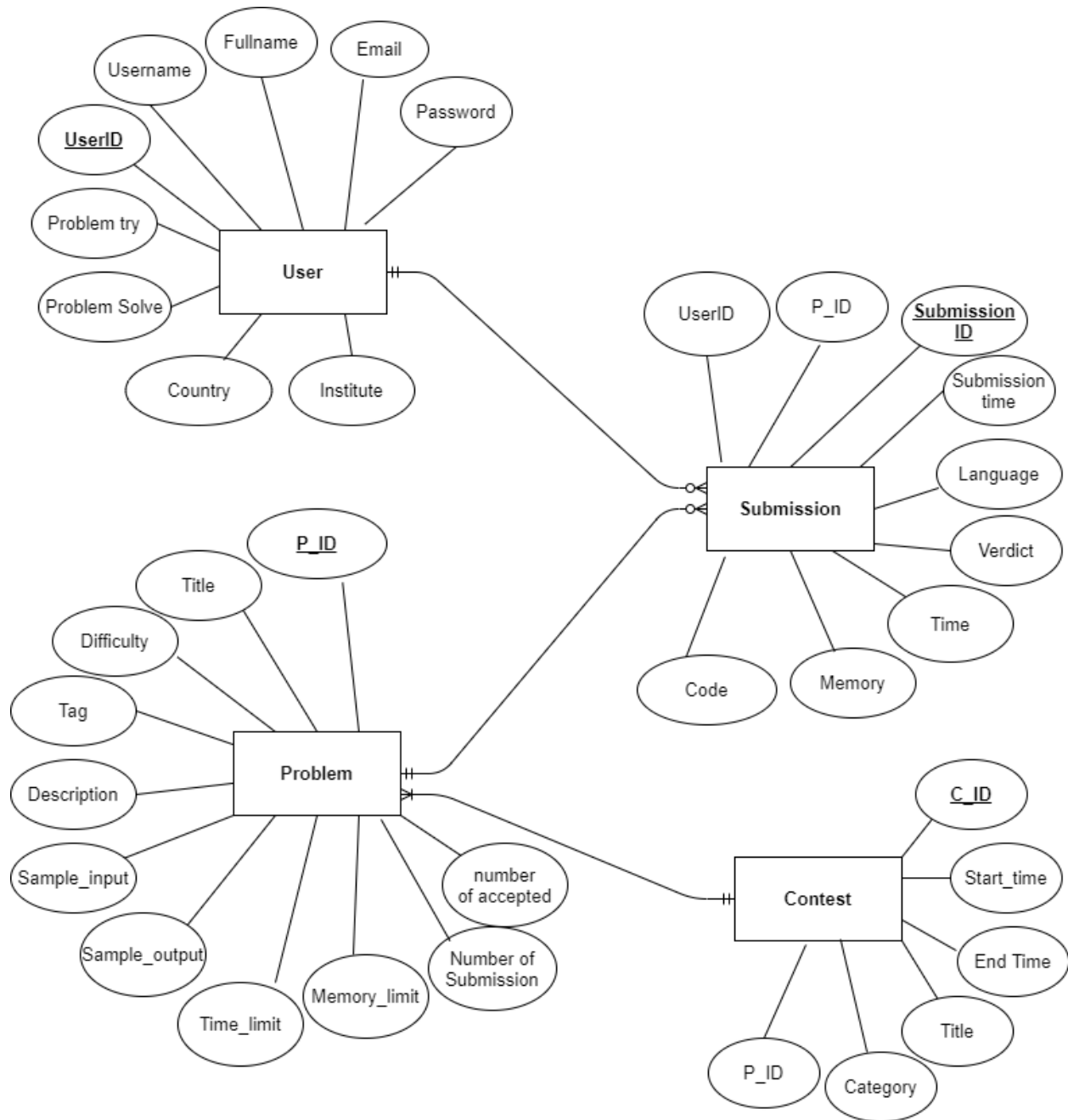


Fig. 4.2. Entity-Relationship Diagram of proposed system.

4.3 USE CASE DIAGRAM

A use case diagram can identify the different types of users of a system and the different use cases and will often be accompanied by other types of diagrams as well. So, we can say that use case diagram is the primary form of system requirements. Use case diagram model the functionality of a system needs to perform. This diagram describes the interaction between actor and use case. The use cases are represented by either circles or ellipses and the actors are represented by human figure.

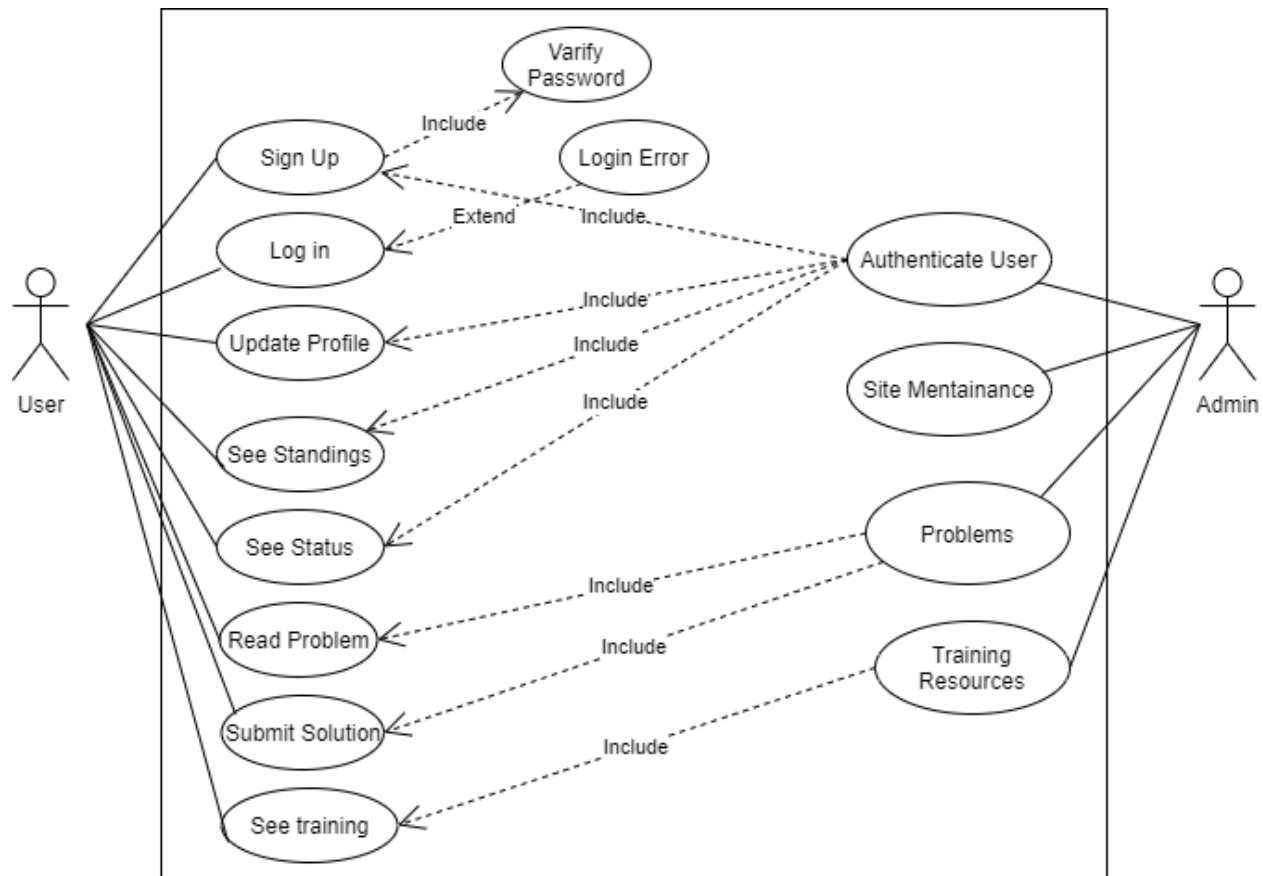


Fig. 4.3 Use Case Diagram of proposed system.

4.4 STATE DIAGRAM

A state diagram is a type of diagram used in computer science and related fields to describe the behavior of systems [26]. It represents the behavior using finite state transitions. It is also known as chart diagram. It represents dynamic models of objects which changes their states in response to events. It is a model of the states of an object and the events that cause the object to change from one state to another. Different states can be represented by a rectangle with rounded corners. It's easy to find out the activity. Here a state diagram has given which is used to model the dynamic nature of the system and so on.

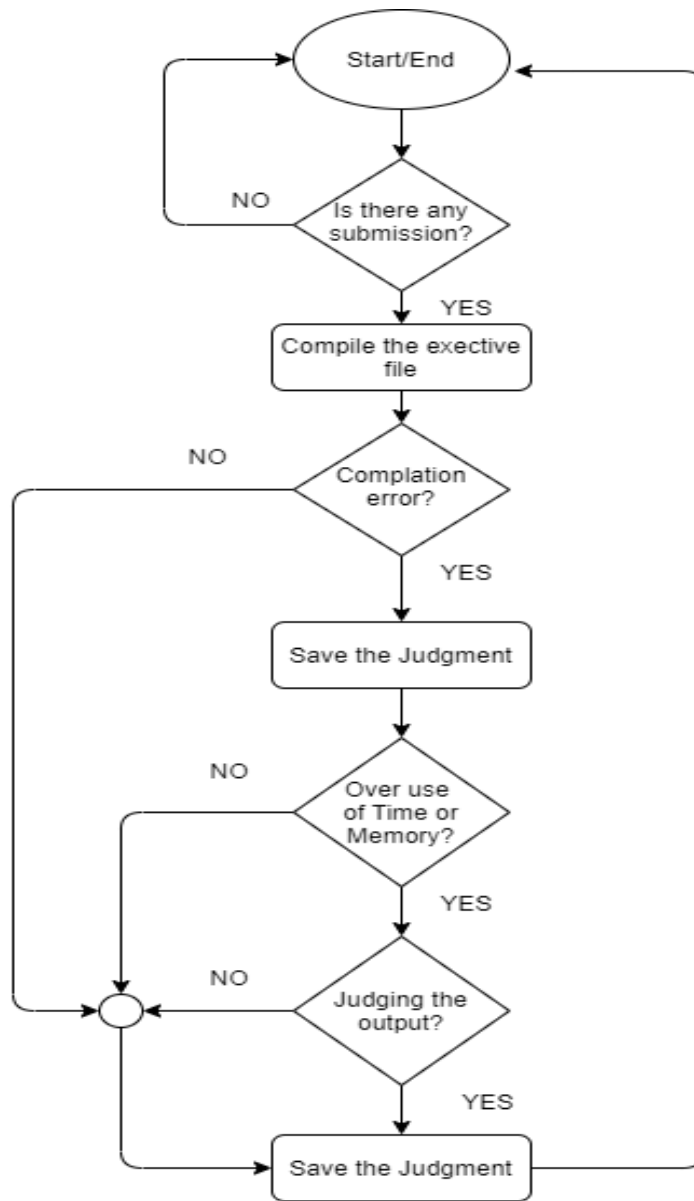


Fig. 4.4 State Diagram of proposed system.

4.5 ACTIVITY DIAGRAM

In Unified Modeling Language, Activity diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency [27]. The activity can be described as an operation of the system. Activity diagrams are used to visualizing the dynamic nature of a system; they are also used to construct the executable system by using forward and reverse engineering techniques [28].

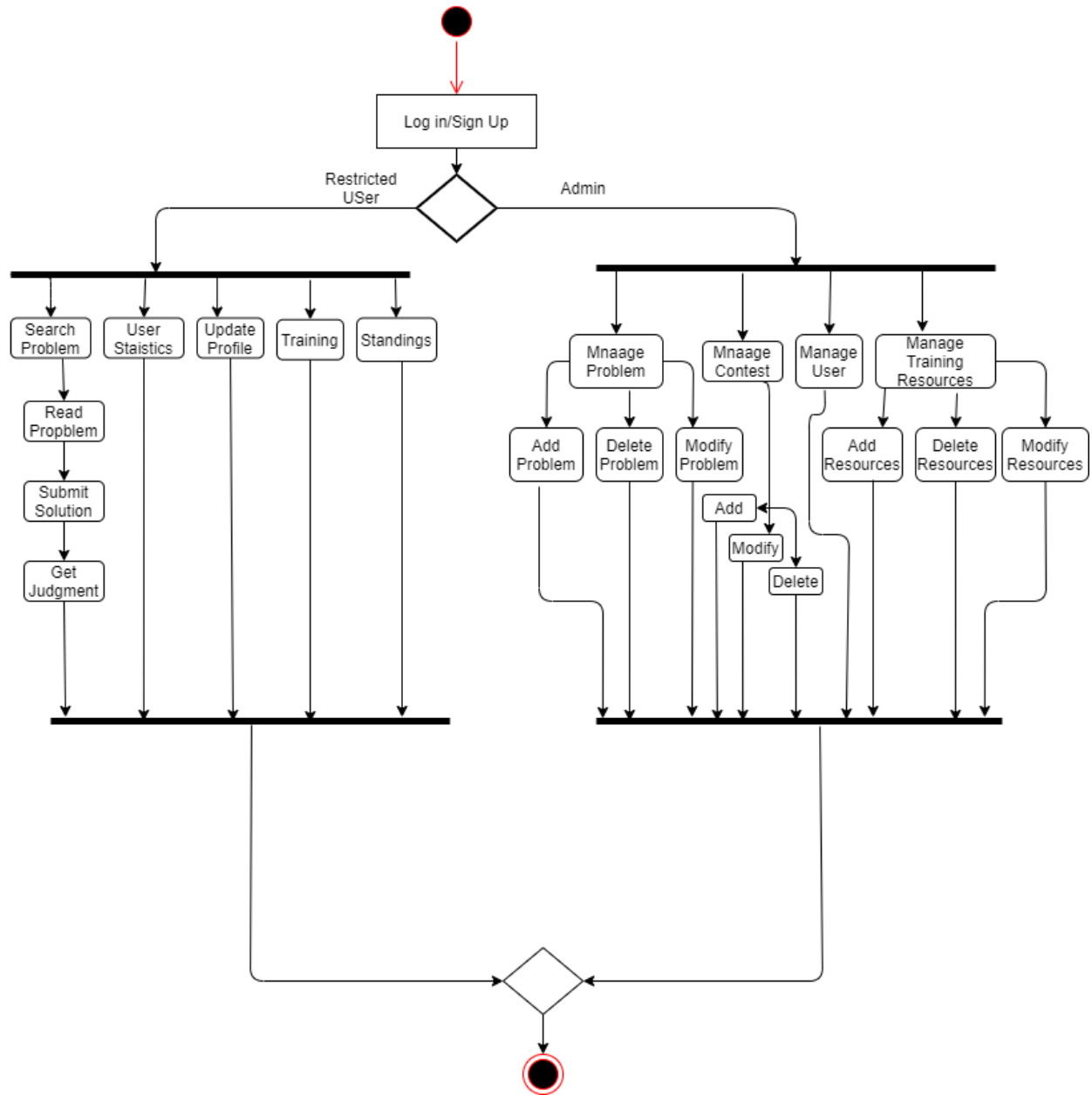


Fig. 4.5 Activity Diagram of proposed system.

CHAPTER 5

IMPLEMENTATION AND EXPERIMENT RESULT

In this chapter, partial implementations will be discussed.

5.1 TECHNOLOGICAL BACKGROUND

Languages: Python3, HTML, CSS.

Frameworks: Django.

Database: Postgresql.

Environment: elementary OS 5.0

Hardware Environment:

- CPU: Intel Core i5
- SSD: 128 GB
- RAM: 4 GB

5.2 DATABASE IMPLEMENTATION

Database is needed for accurately recording data, updating and tracking them on an efficient and regular basis. In this system, there is a database called 'ojdb' consist of 3 tables of data.

- Users: storing and manipulating data from registered users.
- Problems: Stores the detailed information of problems.
- Submissions: Keep tracks all submissions history.

5.3 USER INTERFACE

In information technology, the user interface is the space where interactions between human and machines occur. This is the field of human-computer interaction. This can include display screens, peripherals devices and appearance of a desktop. The goal of user interface design is to produce a user interface which makes it easy, efficient, and enjoyable (user-friendly) to operate a machine in the way which produces the desired result. This generally means that the operator needs to provide minimal input to achieve the desired output, and also that the machine minimizes undesired outputs to the human.

5.3.1 HOME PAGE

Users get login, register option in the left top corner of the home page. If user is already logged then he/she see his/her username, logout option there. User get notice corner, about us in the middle of this page.

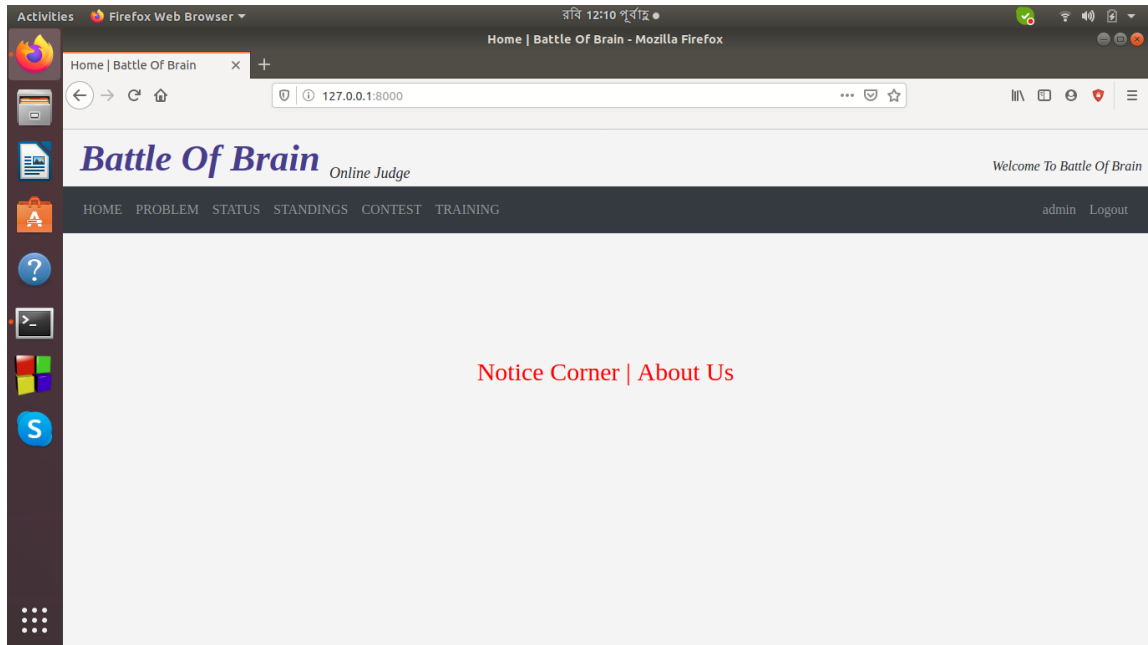


Fig. 5.1. Homepage of Proposed System

5.3.2 SIGN UP FORM

User need to register first to login into the website. It is the registration form snapshot in our proposed system.

 The image shows a web browser window with the title 'Sign Up | Battle Of Brain - Mozilla Firefox'. The address bar shows '127.0.0.1:8000/signup/'. The page header includes the 'Battle Of Brain Online Judge' logo and a 'Welcome To Battle Of Brain' message. A navigation menu contains links for HOME, PROBLEM, STATUS, STANDINGS, CONTEST, and TRAINING. On the right, there are links for 'Login' and 'Register'. The main content area features a 'Sign up' form with the following fields: Username, Full name, Email address, Institute, and Country. Each field has a corresponding text input box.

Fig. 5.2. Sign Up Form of Proposed System

5.3.3 SIGN IN/LOGIN FORM

After completing the registration process user can login into the website through valid credentials.

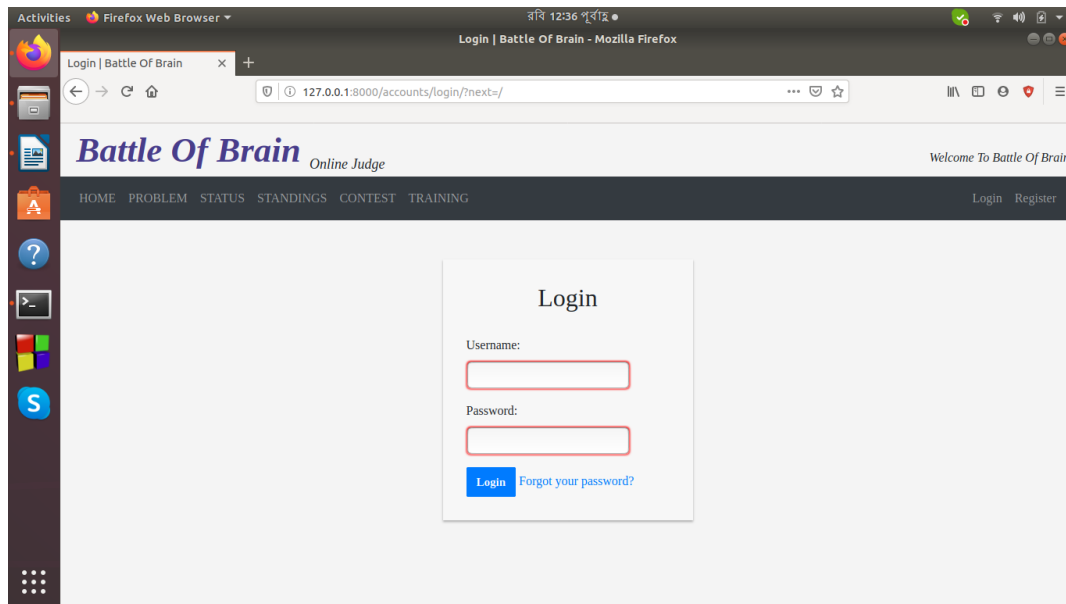
A screenshot of a web browser displaying the login page of the 'Battle Of Brain' online judge. The browser's address bar shows the URL '127.0.0.1:8000/accounts/login/?next=/' and the page title is 'Login | Battle Of Brain - Mozilla Firefox'. The website's header includes the 'Battle Of Brain' logo, the text 'Online Judge', and a 'Welcome To Battle Of Brain' message. A navigation menu contains links for 'HOME', 'PROBLEM', 'STATUS', 'STANDINGS', 'CONTEST', and 'TRAINING'. On the right side of the header, there are links for 'Login' and 'Register'. The main content area features a 'Login' form with two input fields labeled 'Username:' and 'Password:'. Below these fields is a blue 'Login' button and a blue link that says 'Forgot your password?'. The browser's sidebar on the left shows various application icons.

Fig. 5.3. Sign In/Login Form of Proposed System

5.3.4 FORGET PASSWORD FORM

If any user forgets his/her password, he/she can recover his/her password through this form.

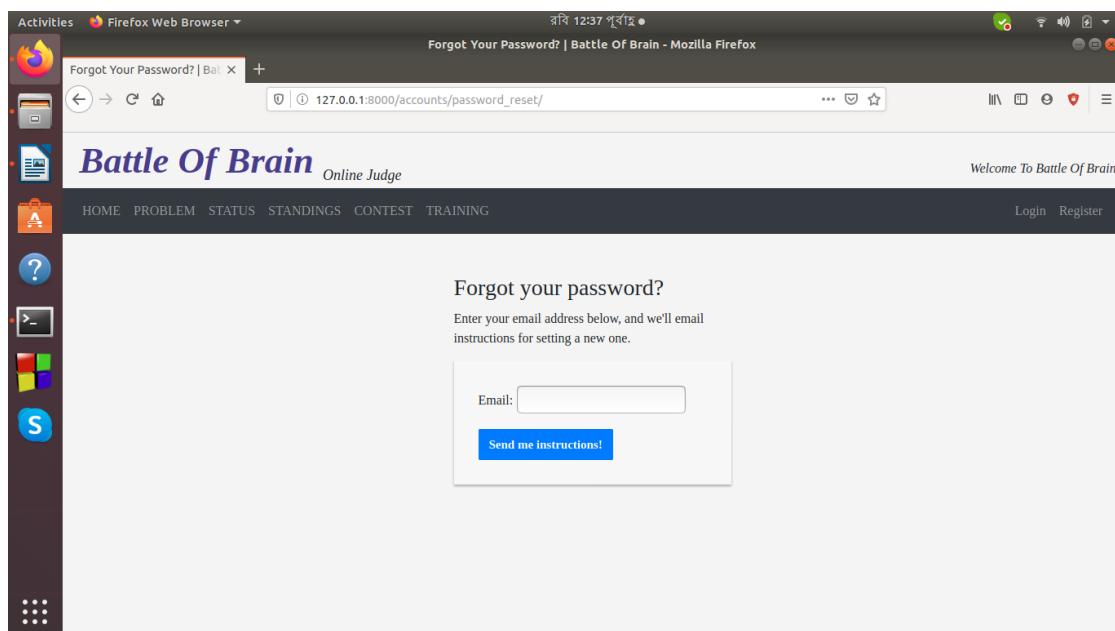
A screenshot of a web browser displaying the 'Forgot Your Password?' page of the 'Battle Of Brain' online judge. The browser's address bar shows the URL '127.0.0.1:8000/accounts/password_reset/' and the page title is 'Forgot Your Password? | Battle Of Brain - Mozilla Firefox'. The website's header is identical to the login page, featuring the 'Battle Of Brain' logo, 'Online Judge' text, 'Welcome To Battle Of Brain' message, and navigation links. The main content area has the heading 'Forgot your password?' followed by the instruction 'Enter your email address below, and we'll email instructions for setting a new one.' Below this text is an 'Email:' input field and a blue button labeled 'Send me instructions!'. The browser's sidebar on the left shows various application icons.

Fig. 5.4. Forget Password Form of Proposed System

5.3.5 PASSWORD CHANGE CONFIRMATION FORM

The screenshot shows a web browser window titled "Forgot Your Password? | Battle Of Brain - Mozilla Firefox". The address bar shows the URL "127.0.0.1:8000/accounts/reset/Mw/set-password/". The page header includes the "Battle Of Brain Online Judge" logo and a navigation menu with links: HOME, PROBLEM, STATUS, STANDINGS, CONTEST, TRAINING. The user is logged in as "admin" and can click "Logout".

The main content area is titled "Change password" and contains the following form:

New password:

• Your password can't be too similar to your other personal information.
• Your password must contain at least 8 characters.
• Your password can't be a commonly used password.
• Your password can't be entirely numeric.

New password confirmation:

Fig. 5.6. Password Change Confirmation Form of Proposed System

5.3.6 USER PROFILE

Any user can view his/her profile by clicking on his/her username which is shown in the top right corner on the page.

The screenshot shows a web browser window titled "admin's Profile | Battle Of Brain - Mozilla Firefox". The address bar shows the URL "127.0.0.1:8000/profile/". The page header is the same as in the previous figure.

The main content area displays the user profile for "admin". It is divided into two sections:

Image

admin's details

Full Name: Admin
User Name: admin
Problem Tried: 24
Problem Solved: 7
Email: admin@gmail.com
Institute: ITMO
Country: Russia
Join Date: March 5, 2020, 4:14 p.m.
Last Login Time: March 8, 2020, 10:09 a.m.

Fig. 5.6. User Profile view of Proposed System

5.3.7 PROBLEM PAGE

Problem page contains problems for practice. User can see the problems by clicking on the problem name. By this search box on user can filter problems according to difficulty level and problem tags.

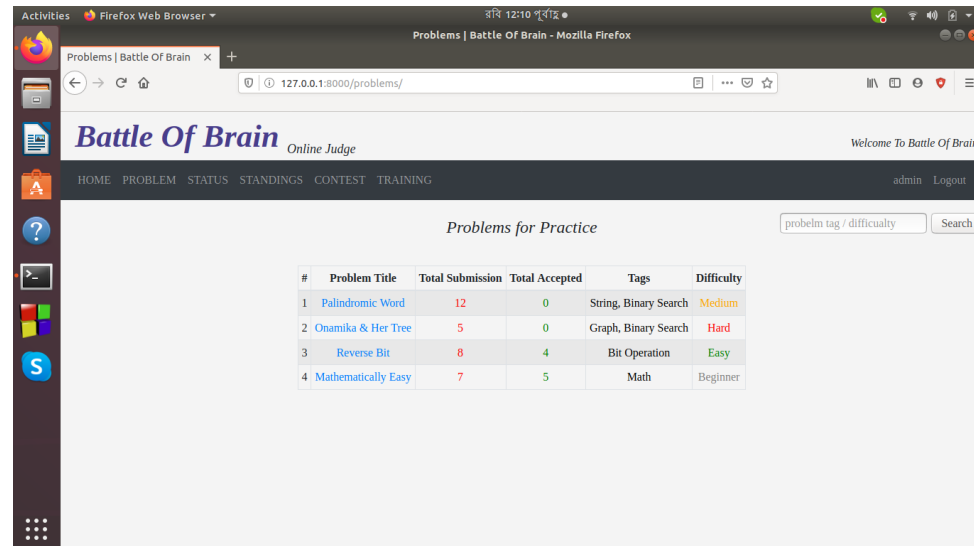


Fig. 5.7. Problem Page of Proposed System

5.3.8 STATUS PAGE

Status page show the submissions verdict. If the solution is correct the submission get Accepted green verdict. Other verdicts are show according to the Judging result. Another thing is on user can filter his/her own submissions by clicking my button on top right corner of the page.

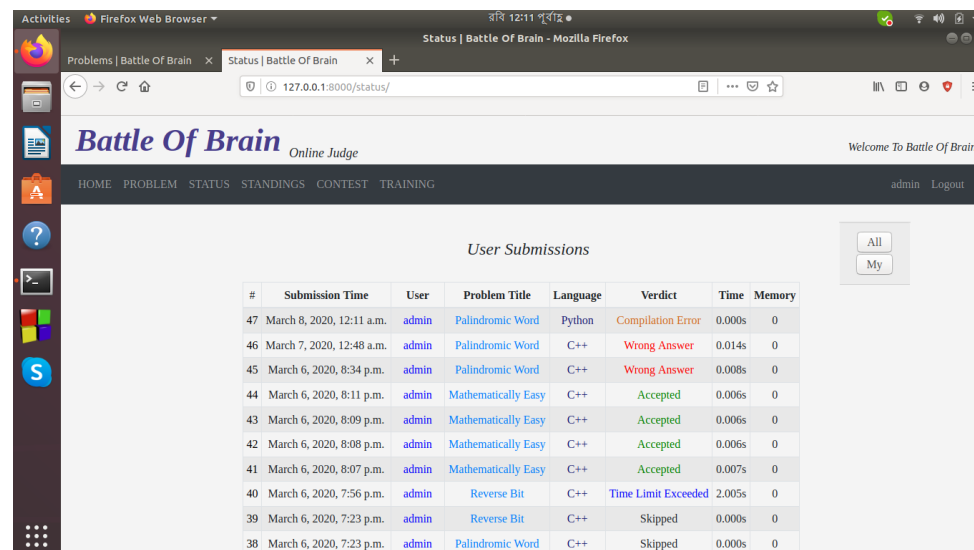


Fig. 5.8. Status Page of Proposed System

5.3.9 STANDINGS PAGE

This page showing all the user information like total attempt, solved, country, institution etc. Rank list is made according to the total number of solved.

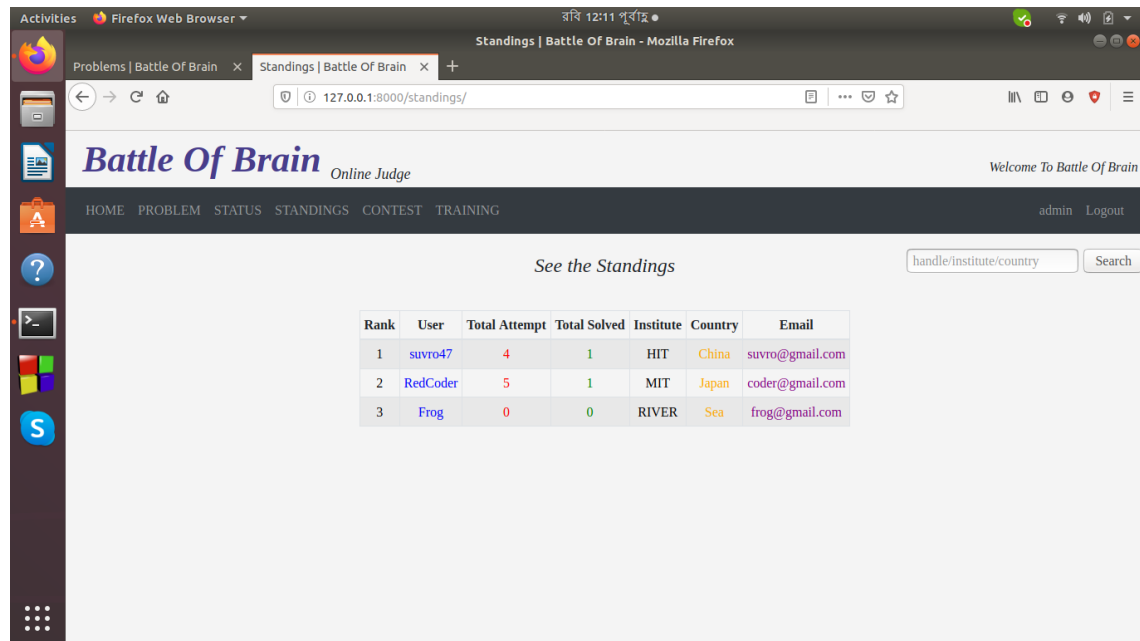


Fig. 5.9. Standings Page of Proposed System

5.3.10 CONTEST PAGE

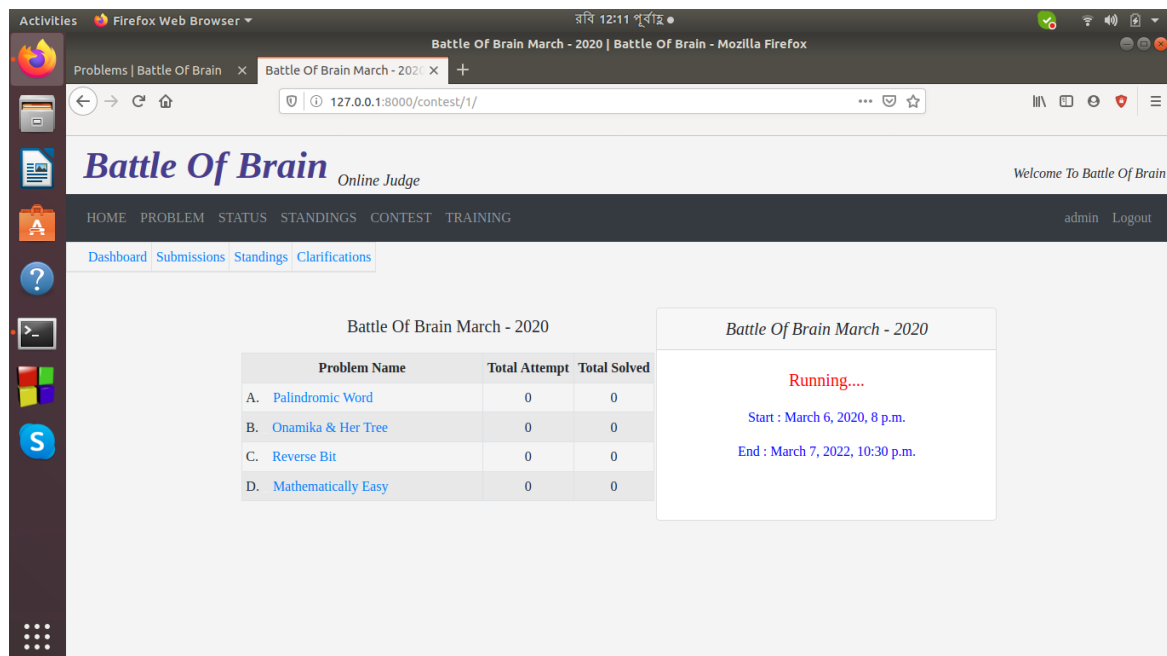


Fig. 5.10. Contest Page of Proposed System

5.3.11 TRAINING PAGE

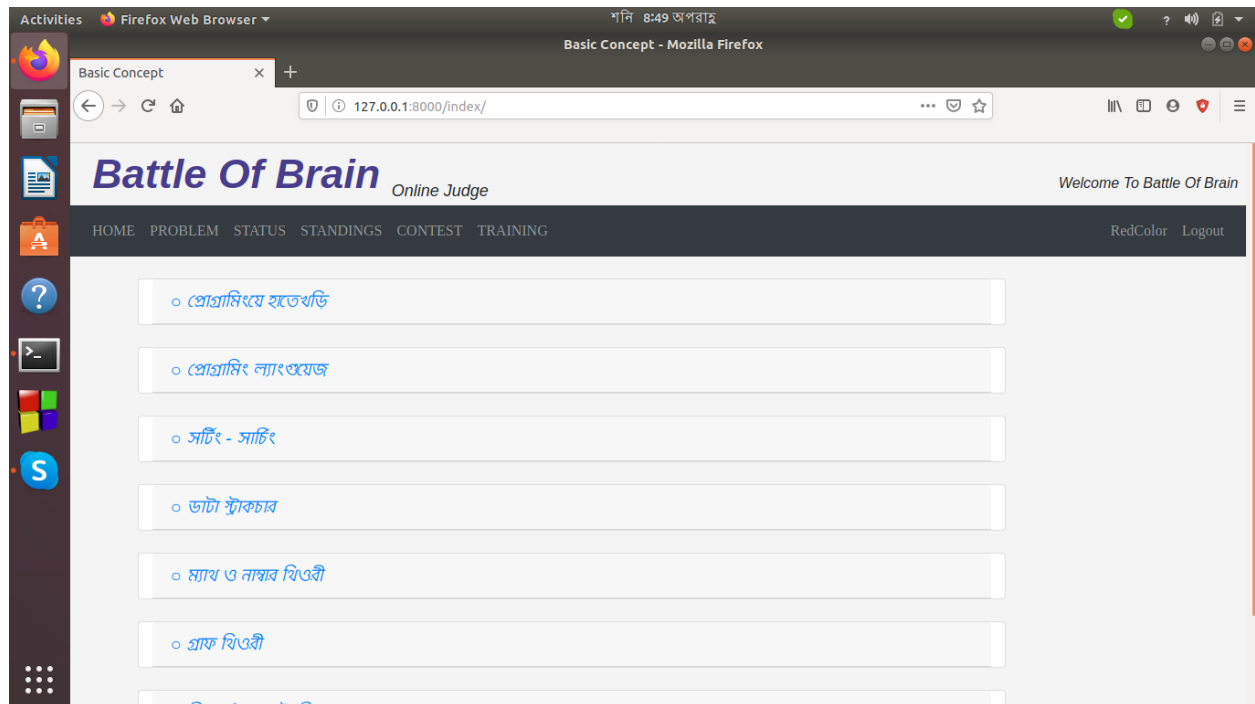


Fig. 5.11. Training Page of Proposed System

5.3.12 BASIC TRAINING PAGE

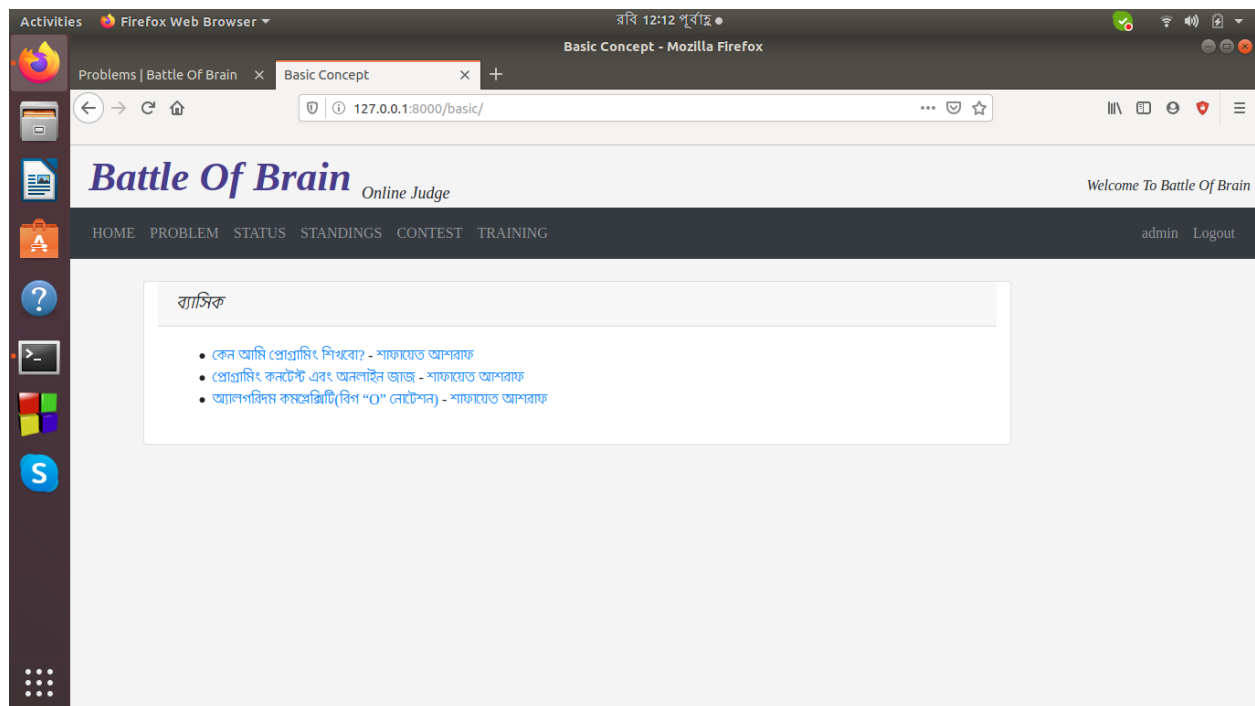


Fig. 5.12. Basic Training Page of Proposed System

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 CONCLUSIONS

The proposed project has been designed and developed aiming to provide a problem solving and training platform for the problem solvers enthusiasts of HSTU. The proposed system will set the base for further development of the problem solvers community at HSTU. The system will surely help to increase the competitive programming skill of the users because the contest arrangement at any given time will be easier for the admins.

6.2 FUTURE WORKS

The project currently supports the solution of three languages C, C++ and Python. In future other programming languages support can be added. More interesting features will be added in the future such as code editor, submitted code downloading features, user to user texting tools like messaging or live chat, contest divisions as like codeforces.

CHAPTER 7

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