

A Survey on Design of Online Judge System

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Abstract - Online judges are systems developed for judging the source code submitted by users, which is next compiled and tested in a homogenous environment. Due to its applications online judges are becoming very popular and are being developed for various purposes. Based on the objectives of OJ's we classify them into systems that support organization of competitive programming contests, enhance education and recruitment processes, facilitate in solving of data mining challenges, online compilers and development platforms integrated as components of other custom systems. Thus, we would like to implement an efficient system which will help students to gain knowledge of data structure and programming skills. The system includes user interface, sandbox judging environment, functions for evaluating scores and updating reports into database. To prevent malicious codes from damaging the system, the online judge system utilizes sandbox, ensuring the safety of the system. The system uses parallel execution and concurrency. These new features make the system more impactful by giving high performance, high reliability and high stability.

Key Words: Online Judge, Competitive Programming, Contests, Programming Skills, OJ Architecture

1. INTRODUCTION

Programming is the heart of computer science, subject in computer science and computing related courses, and there are increasing demands on improving the experience, motivation and efficiency of programming language teaching and learning. In short Programming is the heart of the Computer Science. Many students from the school and colleges lacks in the programming which is required for the computer science related courses and for trendy technologies like artificial intelligence, machine learning, data science and many more. To gain the knowledge of data structure and programming skills platforms like online judge systems are helpful for the students. But many students cannot survive in this growing competition in competitive programming.

There are some problems or system lacks some features or system can be modify to make students to improve their coding/programming skills.

- Most of the online judges doesn't have the facility of teacher guidance.
- Students writes the poor code.

- Some systems don't have plagiarism check or some systems have plagiarism checking mechanism but which is not adding value in OJ system.
- System doesn't provide personalized feedback to the students.
- Low interest in program learning and weak initiative of some students. Some students continue their learning habits in high school, lack of the ability of active learning, self-learning.
- Poor programming abilities of students which reflect when they can't meet the needs of relevant courses and also during employers common evaluation of computer science major and software engineering major students in our university.
- Obvious polarization of students during actual performance.
- Some students have low interest program learning, lack self-learning ability and ability of active learning.

To solve some of the problem mentioned above, many online judges has implemented or proposed new techniques, for example. Instead of plagiarism which is not a good practise to check the code, code similarity check is performed on the code [1]. Also analysing source files, personalized feedback, teaching adjustment are there.

2. METHODOLOGIES

System Design and Sandbox environment

System implemented by is based on B/S architecture. It has two services Web part and Sandbox environment. System is based on micro service architecture. For the faster development of the system's UI, they have used Spring MVC/Spring Boot which is best to use [1].

User is expected to submit the code/program which is next compiled and executed in the system. Submitted code might be a malicious which can bring the system down by large resources, making the compile time more, infinite looping, and many more. To avoid malicious code from damaging system Sandbox Models are used [3] provides security sandbox design which is built in JAVA [1].

[1] This paper has shown full system architecture of system with key technologies which are listed as follows.

Parallel Judgement [1] – Multiple testcases of a program runs on multiple thread without mutual interference.

Spot input/output stream [1] – To avoid the problem of concurrency due to I/O streams, system had implemented std io stream agent which will handle input/output concurrency problem.

Signal interaction mechanisms [1] – This Signal interaction mechanism provides information interaction between web and sandbox side.

Message box mechanism [1] – Will take care of asynchronous behavior of getting result and synchronous behavior of submitting requests.

Sandbox connecting manager [1] – It manages the sandboxes and achieve the load balancing between sandboxes.

Sandbox Business Manager [1] – It handles and checks the state of the sandbox.

Docker Container - Sandbox Environment

Docker Container is standard unit of software, for running quickly and reliably it packages up all the dependencies and the code. Docker Container includes everything as it becomes independent to run an application, it is standalone, lightweight software it includes code, runtime, system tools, libraries and settings [4]. Malicious code cannot harm the system due to isolation and the security to the resources provided by Docker Container. Operating System layers provides virtualization that's why container does not need the OS overhead while running.

Key Features

Fork the Solution; Fork lets you make changes to a solution without affecting the original. You can fetch and use or submit changes to the original and also give points as a royalty.

If a participant has just solved a problem partially and has submitted it, he will only get points on the basis of effectiveness of that solution. But another participant can use this partially solved solution as a boiler plate to build their logic for the solution. In this way both of them will get bonus points as both the solutions were effective to some extent. This can help both participants to improve their programming logic and together can build a more optimized and more effective solution.

Test Case Generation: Existing technique of Custom input field is not helpful as the size of testcases is very large. Basic idea is to generate the testcases for better accuracy and debugging. Contestant can write the program for the generation of testcases as per the constraints of problem.

Output of this program will be the input for the solution of a problem.

3. ADVANTAGES

Docker Container – It provides reliable and efficient evaluation of a solution. Container does not use a lot of memory in order to execute and test the correctness of the program. After the evaluation container is destroyed and resources are released.

Plagiarism check cannot be implemented successfully, that's why Code Similarity Check is the best option for the Plagiarism [3].

Code Quality, Teaching Adjustment, Personalized feedback helps the better evaluation and guidance [3].

4. APPLICATIONS

Competitive Programming: - Online judge platforms are used to host competitive programming contests which can help students to improve their skills in data structures and develop programming logic. It also benefits students' career preparation and advancements, ability to deliver results under pressure, ability to self-assess and rate others work and develop new ways of solving problems with high quality work and time limitation.

Education [3]: - Programming ability cannot be developed just by listening to teachers lectures but should be grasped only with massive and repeated training. In traditional education conductors assess students by grading their homework manually. When it comes to online programming education, only after they submit their programs and programs have been judged by conductors will they get feedback about their programs. It reduces students' enthusiasm for programming training. Proposed system returns feedback to users after compiling and running result.

Online Compiler: - Online compilers are debugging tools which allows you to compile source code and execute it online in a number of programming languages. The online judge system can also be used as online compilers where users can submit the source code in various programming languages and can remotely compile and execute it via a browser.

Recruitment: - Online judges are used as recruitment platforms where freshers as well as experienced candidates can be hired by the employers. Students can compete, build their profiles, showcase their coding skills and based on good results they can get hired. HackerEarth is an online platform whose main objective is hiring talented developers, organizing hackathons, and hosting crowdsourcing-based ideas.

Data-Mining services: - Online judge systems are used to evaluate data-mining algorithms where users execute their code locally using test data and submit the results generated

by the algorithm. **MLcomp** is an example of such an online platform where it stores datasets, thus any user can upload his/her own datasets and algorithms. It is a cloud-based platform.

5. CONCLUSIONS

OJ systems provide a platform for students to master programming ability and can automatically judge the solutions submitted by users in real-time feedback. The main focus of the system is on improving the judgment speed and accuracy, performance optimization to database. The implementations show that the system has high reliability, efficiency, safety and good extensibility.

Docker container being a lightweight virtualization technology, has advantages of high security, high startup speed, faster development and deployment cycles. Our proposed system is course oriented, combined with advantages of OJ's and Docker container to evaluate submissions made by students with the methods such as grading tool, a code similarity checker and a code quality evaluation tool also allows students to login anytime through the proposed experimental system and its implementation. The system can exercise problems, edit, save, debug, run, evaluate the source code of the program, get timely feedback and based on the result leaderboard is also displayed.

With the proposed system, students' interest and enthusiasm in programming learning can be motivated with the features such as leaderboard, teacher guidance and competitive problems. The system greatly reduces the time of guidance, review and feedback of students' programming training, devotes more time and energy to organizing teaching contents efficiently, designing program-training topics, thus improving the teaching quality. Online judge systems are of interest for educational organizations because they support fully automatic and accurate evaluation of student assignments, allowing the teacher to focus on exercise quality and the teaching process. But this can also increase the workload of teaching assistants.

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