

Application of the Online Judge Technology in Programming Experimental Teaching

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ABSTRACT

Code validation is a complicated and overloaded task to the Experimental instructor of Programming courses. In order to solve this problem, an online judging based experimental teaching platform is developed which has the functions of online arrangement experiment for the teachers, online coding and automatic evaluation for the students. Through the application of online judge technology in the experimental teaching of data structure and other courses, it not only can improve the students' problem solving ability but also can assist the teacher to review the experiment quickly and correctly, greatly reducing the workload of teachers, and improving the quality of experimental teaching obviously.

Keywords: *Online Judge Technology, Experimental Teaching, Programming*

1. INTRODUCTION

Experimental practice of programming, data structure and algorithm, and other courses include basic links, such as general classroom explanation, students' written assignments, computer practice and experimental evaluation. The long-term practice shows that this traditional experimental teaching mode dose have many shortcomings and deficiencies. For the experimental code submitted by students, teachers need to re run, input test data and compare the output data before they can know whether the code is effective. This process undoubtedly increases the workload of teachers and reduces the work efficiency. The emergence of online judge system [1, 2] can solve these problems.

At present, there are many researches on the experimental teaching platform of computer software courses supporting online evaluation technology. For example, CourseMarker [3] is an automatic evaluation system to promote students' programming practice. Boss[4] is an auxiliary teaching system for programming courses, which integrates online evaluation system function and code duplicate checking function. PC² Program Contest Control System [5], developed by the University of California, provides programming contest control, online judge and other functions. Toledo R Y et al. [6] proposed a personalized problem recommendation system combining traditional collaborative filtering technology with online judge.

The National University of Singapore uses the online judge system in the teaching evaluation environment of data structure and algorithm [7]. In addition, Hangzhou University of Electronic Science and

technology has established a multi-level programming training mode [8] based on HDOJ [9]. Peking University's "hundred exercises"[10] based on POJ [11] and "Jiudu" [12] based on HUSTOJ [13] are respectively applied to the computer-based examination of programming courses and the computer-based examination of graduate job wanted and graduate interview. Shandong Normal University used online judge technology in the experimental teaching of programming, which improved the teaching effect of programming courses [14]. Beijing University of Chemical Technology tried to introduce the online judge mode based on ACM competition in the practical teaching of compiler principle, and achieved good results [15]. Anhui Normal University put forward the practice teaching mode based on online judge, and made beneficial exploration and summary in teaching methods, experimental content organization and difficulty arrangement, assessment scheme and so on [16]. The assignment and assessment methods based on online judge proposed by Shandong industrial and Commercial University have improved the current situation of low completion of programming assignments and lack of process assessment in performance evaluation [17]. Online judge based blended teaching practice [18], programming behavior analysis [19], learning path recommendation [20] and course teaching evaluation [21] have also received high attention and analysis.

It can be seen from the above that the construction of an experimental teaching platform supporting online judge is of great value and significance to improve the quality of experimental teaching of computer software courses. Therefore, this paper designs and implements

an experimental teaching platform supporting online judge for programming course, which not only reduces the workload of teachers, but also improves the practical ability of students. To a certain extent, it also improves the disconnection between experimental teaching and classroom teaching, and solves the problems of poor accumulation and sharing of experimental data and experimental resources.

2. DEMAND ANALYSIS of EXPERIMENTAL TEACHING PLATFORM SUPPORTING ONLINE JUDGE

The platform includes three roles: students, teachers and administrators. When logging in as a student, it provides functions such as experiment assignment, practice experiment, online examination, student information, source code upload, forum and other functions; when logging in as a teacher, it provides functions such as experiment release, test setting, teacher information, similarity detection, forum and etc.; when logging in as an administrator, it provides student data, teacher data, experimental data, modification data, system settings, and security settings, forum management and other functions. Figure 1 shows the swimlane diagram of core business among different roles.

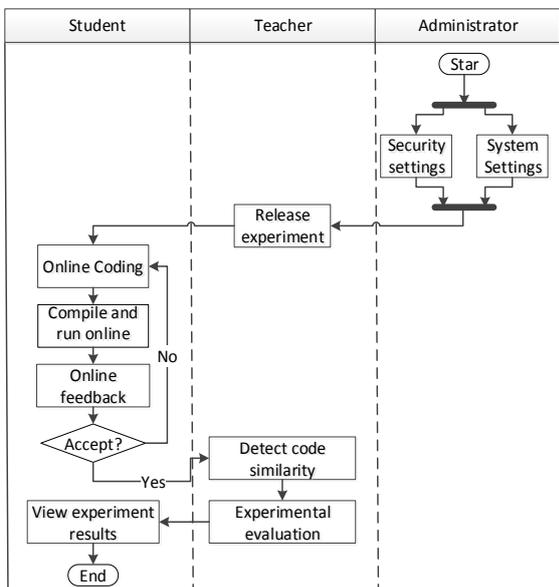


Figure 1 Core business relationship by role

3. DESIGN OF ONLINE JUDGE MODULE

Online judge is the core function of the experimental platform for programming courses. Firstly, students can check the experiments to be completed by selecting experimental topics, and then program online. Then,

enter the online judge phase, that is, the code is submitted to the background server for compilation, and the server executes according to the input data specified by the teacher. Finally, the results are fed back to the students, and the students choose the next operation according to the results. If the results are correct, it means that the experiment is completed; if not, they can modify, re submit, until it is correct. The flow of the whole online experiment is shown in Figure 2.

The specific steps of automatic judge on server are as follows:

Step 1: Get the solution code according to the task number and create a temporary source code file.

Step 2: Call the compiler of the corresponding language to compile the source code file. If it passes the compilation, it will jump to step 3. Otherwise, it will be regarded as a compilation error. Save the compilation error information and jump to step 6.

Step 3: Run the compiled program of step 2 to restrict the program from executing illegal operations. Start the timer and load the standard input data prepared by the teacher and wait for the output data. If the operation is abnormal, save the exception information and jump to step 6. If the memory consumption exceeds the limit, jump to step 6. If the time consumption exceeds the timer, jump to step 6. Otherwise, the output data is compared with the standard output. Generally, there are three kinds of comparison results: complete matching when removing the front and back blanks and line feed, mismatching when removing the front and back blanks and line feed, and partial matching.

Step 4: If there are other test data, go to step 3.

Step 5: Give the time cost and space occupied and calculate the score.

Step 6: Save the results, upload the source code file to the corresponding experimental folder and return.

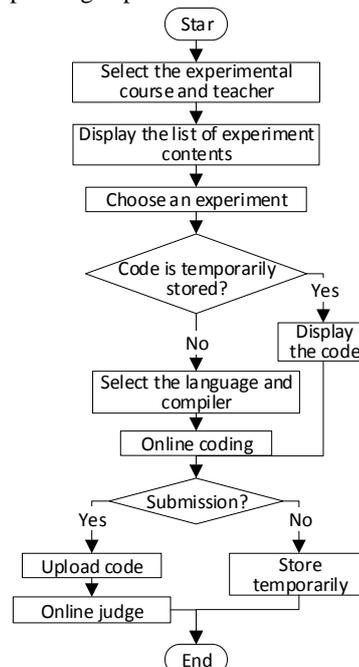


Figure 2 Operation flow of online experiment

4. IMPLEMENTATION OF ONLINE EVALUATION MODULE

Based on the above analysis and design, an experimental teaching platform supporting online judge is developed and applied in experiment teaching of data structure. Among them, the implementation effect of online judge module is as follows.

When students log in, they will determine the corresponding teacher ID, semester ID and course ID according to the current student number, password and experiment course name, and then obtain all the corresponding experimental topics. When you click the title number of a subheading, the platform will automatically obtain the teacher ID, semester ID, course ID, experiment number and sub experiment number, and the title requirements will be displayed on the page, as shown in Figure 3.

Figure 3 Online submit experiment interface I

Select the "submit" button in Figure 3, and a code editing box will be displayed below, as shown in Figure 4, where students complete the code writing. Then, click the "submit" button in Figure 4, and the platform will start the automatic judge and automatic upload of the code.

```
#include <stdio.h>
#include <stdlib.h>
#include <iostream>
using namespace std;

typedef struct node{
    int data;
    struct node *next;
}Lnode, *Linklist;

Linklist A,B,C;

Linklist init_linklist(){
    Lnode *s,*r,*L;
    L=new Lnode;
    L->next=NULL;
    r=L;
```

Figure 4 Online submit experiment interface II

When you submit the correct code, you get the judge results shown in Figure 5.

Lab Number	Status	Time(S)	Memory(B)
1.2	Accepted	0	1072
2.1	Accepted	0	2050
2.2	Accepted	0	4000

Figure 5 Experimental result-Accepted

When the compile error code is submitted, the judge result as shown in Figure 6 is obtained.

Lab Number	Status	Time(S)	Memory(B)
1.2	Compile Error	0	1080
2.1	Accepted	0	2050
2.2	Accepted	0	4000

Figure 6 Experimental result-Compile Error

When you submit the code with the wrong running result, you get the judge result as shown in Figure 7.

Lab Number	Status	Time(S)	Memory(B)
1.2	Wrong answer	0	1220
2.1	Accepted	0	2050
2.2	Accepted	0	4000

Figure 7 Experimental result-Wrong answer

5. CONCLUSION

Through the application in experiment teaching of data structure, the experimental platform with online judge function as the core improves the automation level and accuracy of experimental judge, effectively reduces the workload of teachers, and improves the quality of experimental teaching. In addition, the platform has code similarity detection function, which can effectively control the experimental plagiarism behavior. In the next step, we will conduct in-depth research on multi file judge and duplicate checking, and combine with MOOC to expand the online openness of the platform.

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