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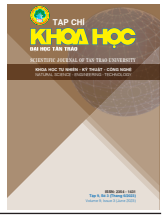

AUTOMATIC ASSESSMENT SYSTEMS IN TEACHING PROGRAMMING COURSES AT UNIVERSITY

Quoc Tuan Nguyen, Thi Thu Phuong Tran

Hanoi Metropolitan University, Vietnam

Email address: nqtuan@hnmu.edu.vn; tttphuong2@hnmu.edu.vn

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Abstract:

The article proposes a number of automatic assessment systems to support lecturers in teaching programming courses, helping to improve training quality and reduce effort in the teaching process. The systems support the organization of the test to assess programming skills and allow candidates to take the test online via the Internet or a local area network (LAN). The system accepts candidates' work and automatically scores completely objectively on pre-built test sets, not influenced by subjective opinions or psychology of the examiner.

Keywords:

Automated rating system, programming, CMS, automatic scoring, Edusoft.

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Nguyễn Quốc Tuấn, Trần Thị Thu Phương
Đại học Thủ đô Hà Nội, Vietnam
Địa chỉ email: nqtuan@hnmu.edu.vn; tttphuong2@hnmu.edu.vn
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Tóm tắt

CSDL về KH&CN đóng vai trò quan trọng đối với mỗi quốc gia, vùng lãnh thổ vì nó lưu trữ các thành quả nghiên cứu khoa học và phát triển công nghệ của mỗi quốc gia. Trong xu thế chuyển đổi số hiện nay, các quốc gia đã và đang đầu tư mạnh mẽ cho việc số hóa và xây dựng các CSDL lưu trữ, quản lý dữ liệu khoa học và phát triển công nghệ phục vụ phát triển kinh tế - xã hội, đảm bảo an ninh, quốc phòng. Vì vậy nhóm tác giả đề xuất xây dựng một hệ thống quản trị, khai thác thông tin tích hợp CSDL KH&CN trực tuyến với mục tiêu chuẩn hóa dữ liệu KH&CN và xây dựng hệ thống liên quan kết nối giữa các CSDL KH&CN.

1. Introduction

Programming language are one of the important subjects of the information technology (IT). Learning to program on a computer is difficult and requires a lot of effort and hard work from students. Students need to do a lot of exercises and write a lot of programs to improve their programming skills. To improve students' programming skills, an effective and widely used method is to evaluate through programming tests [1] With the development of IT, the assessment of student learning outcomes by tests can be done entirely through the system installed on the computer network environment, the use of these systems often called programming test environments.

In the university teaching environment, the programming test environment will greatly support the learning, self-study process and algorithms of students because students can access a library of exercises that very large with all difficulty levels. The assessment process is also automatic, so that students can self-study, improve their programming ability as well as test the algorithms they have learned. Students can register to these servers to participate in the testing and assessment process [1]

With manual grading, the lecturer takes a lot of time, hard to check and correct all students of a class. Especially, in the period when students are just learning to program, a program can make a lot of mistakes, requiring the lecturer to check and correct many times. With the current situation of more than 30 students/ practice group, it is very difficult to guide and shape practice skills. With each programming practice, the following properties must be satisfied: correctness, efficiency, and universality. However, students often do not argue all cases of the problem or do not know

whether their implementation algorithm has achieved efficiency or not.

Therefore, in order to support students to self-check their results in the learning process, practice programming skills while minimizing the time and effort of the lecturer, we propose several grading systems. automatic programming. The system receives students' work and automatically scores completely objectively on pre-built test sets. The system will then display the results of the student's work.

2. Our work

2.1. Overview of the automated rating system

In general, the teaching, practice and assessment of programming skills have some difficulties:

With manual grading, the lecturer takes a lot of time and it is difficult to check and correct all students. Especially, in the period when students are just learning to program, a program can make a lot of mistakes, requiring the lecturer to check and correct many times.

With each programming practice, the following properties must be satisfied: correctness, efficiency, and universality. However, students often do not argue all cases of the problem or do not know whether their implementation algorithm has achieved efficiency or not.

Many students still have not determined the input and output of the problem or some others arbitrarily add or subtract data in / out, so they often do not meet the standard formats of the problem exams such as Olympic or ACM/ICPC (International Collegiate Programming Contest).

For students of Information Technology, the evaluation of algorithm quality in terms of program runtime, efficiency, and ability to cover difficult situations cannot be comprehensively assessed through analysis programme. Therefore, to support students to self-check their results in the learning process, practice programming skills and reduce the time and effort of teachers, the use of an automatic grading system Teaching support is essential.

From the above difficulties, using automatic grading software compared to traditional grading will have the following advantages: Automating scoring operations, avoiding confusion when scoring and ranking. The scoring process is completely objective on pre-built test sets, unaffected by subjective opinions or the judge's psychology. The printing of tables, retrieving statistics is done completely automatically and accurately. Those statistics can be integrated into other software to make reports and draw lessons for the following exams. After the exam is over, the data for the exam can be published and other candidates can practice on the tests, then use the automatic grading program to self-assess instead of having to invite a panel of judges to re-evaluate [1]

As the development of information technology, the process of passing the test can be done entirely through the computer network environment, the use of these systems is often called the test environment. program. There have been many different softwares to do this job such as: Codeforce, SPOIJ, DEMOJ, SPHERE, Themis, CMS,.. These softwares have been deployed to serve the National and International Informatics Olympiad as well as self-learning programming for users.

For the university teaching environment, the programming test environment will greatly support the learning and self-study process of programming languages and algorithms of students. Students have access to a huge library of exercises of all difficulty levels. The assessment process is also automatic, so that students can self-study, improve their programming ability as well as test the algorithms they have learned. Students can register to these servers to participate in the testing and assessment process. In order to well support the teaching of programming modules of lecturers and students' learning, the article proposes a number of automatic programming evaluation systems that have been applied at universities around the world and Vietnam.

2.2. Contest Management System (CMS)

Exam Management System (CMS) is an open source marking system that has been used in many international programming exams. CMS can conduct programming testing on languages: Java, Pascal, Python2, Haskell, PHP, C, C++, C#, Python3, Rust [2] The system has the following basic properties [3]:

Security: Although the primary security measure for a contest is to isolate the contestant from the grading system, there must be a connection between the two, and the scoring system must minimize the path of attack. system work.

Stability: Even if there is an error, the system will not crash, ensuring the continuity of the system.

Open Source: The CMS is easily accessible, free, and open source.

Extensible: New card styles or rare dot styles can be added through plugins.

Compatibility: CMS does not interfere with quiz or test creation, does not require a minimum number of graders, or special network configuration.

Ease of use: CMS provides complete documentation for administrators, developers and candidates; does not require a deep understanding of the internal engineering of the system.

Figure 1 depicts the components of the CMS system, the system includes many services, the services can be distributed distributed on many servers. Services include:

LogService: Logs all messages sent in the system, for contest logging purposes.

ResourceService: collects all data about services running on the same server. Start services when required

Checker: Run regularly, periodically control all services in the system

EvaluationService: Maintains a queue of submissions. Do the compilation of each submission and run it on the test suites. This grading job can be sent to the workers.

Worker: do the grading work in the sandbox.

ScoringService: Collects all the scores, calculates the score, and submits this result to the leaderboard.

ContestWebServer: Webserver that contestants log in to and post on.

AdminWebServer: Webserver to administer the exam system.

RankingWebServer – display the rankings for external viewing. This server should be outside the CMS system to avoid the system being overloaded (when there are many viewers).

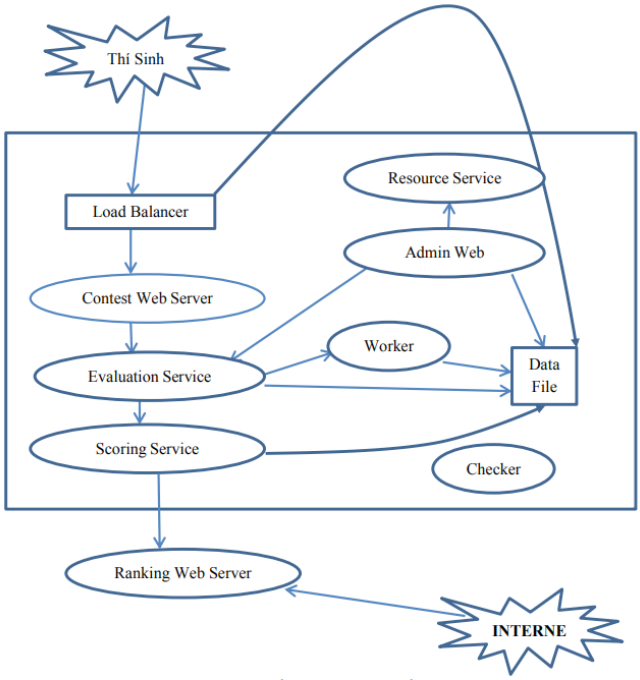

Figure 1. CMS components

System has some fuctions:

Contest Manager: Helps manage contests and set up contest parameters

Manage assignments and test sets: Allows teachers to upload assignments to the system. Exercises are uploaded as pdf files. To evaluate the optimal level of programming, the instructor will specify the maximum running time and maximum capacity for the program. Each exercise posted will be accompanied by one or more test sets to evaluate the candidate's work.

Compilation and grading: Allows candidates to send attached source code files to the system. The grading process is illustrated by the flowchart in Figure 2.

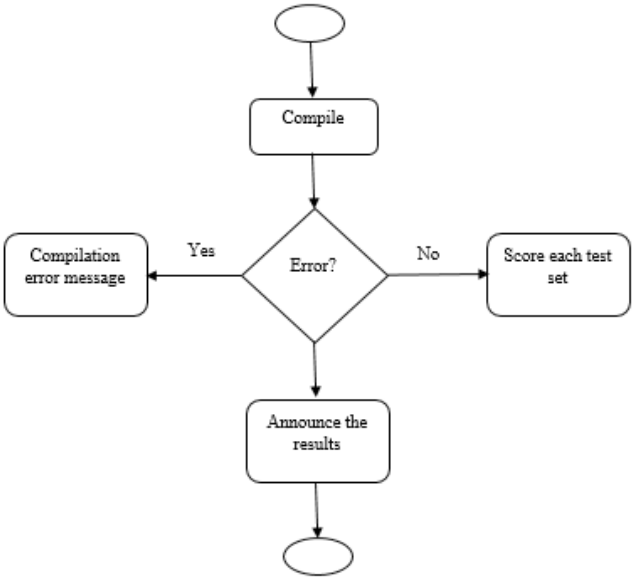

Figure 2 Compiler flowchart

Manage work results: Allows students to view the results of their work. Students can review their work, edit it and submit it for re-marking. Instructors can also view the results and details of each student's work.

Manage student list: This function allows lecturers to create new student lists and add information for students.

Through the process of researching and implementing the CMS system, we found that the system has the following advantages and disadvantages:

Advantages: The system can be installed on a local server, so teachers can be completely proactive in assigning assignments with levels suitable for each student. The system helps teachers to accurately assess students' problem solving ability. The system can evaluate many different languages such as Pascal, C, C++, Python, Java, etc

However, in the process of implementing this system, there are also some limitations such as: the interface is not friendly to lecturers and students; Only one contest can be created on one server at a time; the system does not create the exam structure, so when applied to the test, it is not possible to create different sets of questions in the same contest.

Currently, the teaching and evaluation of programming modules at the Faculty of Natural Science and Technology, Hanoi Capital University uses the CMS system. In addition, the CMS system is also applied in the Informatics Olympiad of the faculty and applied in the Young Informatics contest in Cau Giay District in 2022.

The system has received more than 15,000 submissions, the system has given feedback to the candidates after submitting. The system returns the results of the submissions such as a score or an error message if the candidate's program fails. The system test results for programming competitions clearly show the effectiveness of the system.

2.3. Edusoft.vn

Edusoft system is a learning social networking site, supporting teachers and learners in the process of teaching and learning, especially programming subjects [4] The system can support testing in many different languages such as: Pascal, C, C++, Java, Python, PHP, etc and fully customizable difficulty of the questions. Within the scope of the article, we focus on describing the outstanding features of the system in learning, testing and evaluating programming subjects.

As a teacher, the system allows creating classes, providing learning resources, managing question banks, classifying questions, and creating exam structures. Learners, after logging in to the system, can join the class according to the code provided by the teacher,

exploit learning resources, do and submit assignments to the automatic grading system.

With assessment test, Edusoft has question bank management functions. In this group of functions, the system provides management of question types, questions, and structure of exam questions. Student information and test results are implemented by the system through student management and assessment results reporting.

The question type management function, the list of question types is displayed in the form of branches, making it easy to build, classify and edit. This function allows adding, editing, deleting question types. Question management is done through displaying a list of questions (including information fields: question name, question type, question structure, notes), question classification (based on level / structure). question structure), add new, delete questions. Features to build Exam structure based on Name, Time, Number of questions (selected from Question Bank)

Manage Students based on account list and class list. The student management is displayed in a tabular form with information fields: Student ID, Full Name, Email, Class, Activation Status and Creation Date. After students submit their work, the system will evaluate automatically, the results are displayed in tabular form. The function helps the teacher to see the results of the students. In addition to the tabular display, the system allows to export the results in excel format.

Through the process of researching and using the Edusoft system, we found that the system has the following advantages and disadvantages:

Pros: Edusoft offers a wide range of operational features and several other learning management systems. Learning resources can be put by teachers in libraries (Library), folders (Folder) then share them with different groups. Edusoft has an additional feature to create and schedule posting notes (Note) which is quite convenient. In addition, Edusoft also provides a feature to track learning progress through grading. Thereby visualizing the learning process of students and providing a lot of useful information, helping teachers make reasonable adjustments while the learning process is happening. This feature also makes students self-aware of their own progress and improves learning motivation. Moreover, an outstanding feature of Edusoft is that it is possible to create different topics in one original set. This helps teachers to create different tests on an existing set of topics to ensure objectivity for testing.

However, Edusoft also has some disadvantages such as not having the ability to personalize learning goals and activities for students. In addition, Edusoft is not a completely free site, some extra features have to be paid such as wanting to expand the storage capacity of resources, etc

3. Conclusions

Nowadays, with the application of science and technology in teaching has become a trend, especially the application in teaching programming courses at universities is extremely meaningful.

There are many tools available today to support the teaching and assessment of programming courses. However, with the specific conditions of Hanoi Metropolitan University, the authors suggest two systems, CMS and Edusoft that support the teaching and evaluation of programming courses.

For the CMS system, just install it on a server, the system can allow to evaluate the work of 100 students/ class. The feedback system is relatively stable. However, the system cannot generate the exam structure, so it is difficult to apply the system to create tests on a set of questions. In addition, at a time, only one class can be opened on a server, which also makes it difficult to teach many programming classes at the same time.

For the Edusoft system is a learning social network, in terms of technology, we cannot control it, so we have to depend on service providers. However, the Edusoft system can overcome the disadvantages of CMS such as allowing multiple layers to be created at the same time. Moreover, Edusoft allows teachers to create exam structure, so using the system in testing and evaluation is very suitable.

As the above comments, we see that each system has its strengths and limitations. Therefore, instructors will base on specific needs and circumstances to choose the right tools for their teaching, making the teaching of programming courses effective and exciting for students.

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