Developing the information system “Test Solver” applied for a Programming Contest

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Abstract. The paper dwells on a web-based information system “Test Solver” development for a programming contest. The results of analogs analysis are commented: closed or limited access to these systems; outdated interface and framework; complicated or unfriendly user interface; a system which is impossible or not easy to install on one’s own server. The means used to establish the system are concerned. Web programming tools HTML5, PHP 7.2, MySQL 5.7, JQuery, AJAX and the Materialize framework were used for the development of that software. The modules are outlined; the algorithms of the system are set out, such as adding problems and arranging the contest. The stability research was carried out during the programming contest in Sholom-Aleichem Priamursky State University. 11 students took part in it and 15 problems for the contest were made up. The system “Test Solver” has proved to be a stable foundation for preparing competitions of similar types. The system “Test Solver” might be added with more flexible settings, the multi-stage leagues, implementation of system of points taking, including bonus ones. Also at the moment the software has tools for testing in programming languages C/C++, C#, Pascal. In the future it is planned to add Python, Java.

1. Introduction

Nowadays, there are a lot of opportunities for students in the programming field to make full use of their capabilities in the world. Almost each organization dealing with software and hardware, as well as universities regularly hold computer programming contests. Actually, such contests are aimed to compete, and therefore, recruit potential staff members for the future. At the same time, during the current contests, ready-made automated systems are being designed or used, providing time limit, loading of problems, checking students’ code and total results. There are many software developments designed to automate or simplify the work of the organizing committee and team coaches. Some of them (Dudge [1], Sharif Judge [2] etc.) are used at the moment, but haven’t become available yet and have extremely small information. Some of them have solid researches written, such as Mooshak system [3]. In addition, there are projects systems for testing tries, but they are more likely to be training programming platforms [4].

There are a number of methodological developments that help team coaches and participants in preparation for contests [5]. Some studies on the use of ACM programming systems for training theoretical aspects of programming [6], some are used for training within the framework of the academic discipline [7]. There are also studies on the organization of the contests without using such information systems [8, 9]. In addition, sufficient number of studies prepares for programming contests as a part of computer science [10], preparations for contests through blended learning activities [11].
A number of the following drawbacks were identified after analyzing modern software for arranging programming contests Moosha 2.0 [12], CATS [13], Yandex.Contest [14], CodeForces [15], PC² [16], DOMjudge [17], ACMP [18]:

- closed or limited access to these systems;
- outdated interface and framework;
- complicated or unfriendly user interface;
- a system which is impossible or not easy to install on one’s own server.

According to the analysis of the current software, it turned out to be necessary developing a new type of information system for programming contests. It was desirable to consider disadvantages. In addition, the information system would rather have the minimum possible threshold for participants to register, so to make contests in a indirect participation possible.

2. Methods

When researching the platform types in programming contests, it was decided to design a web-based system using web programming tools HTML5, PHP 7.2, MySQL 5.7, Jquery, AJAX and Materialize framework.

The functions of the information system “Test Solver” are mentioned below:

1. An opportunity to store data regarding past and present contents, registered users and downloaded problems.
2. An opportunity to register and authorize users in the information system.
3. A capability to develop, edit and delete programming contests and problems.
4. Browsing a list of contents and problems in the information system.
5. Authorized users’ participation in contests.
6. An automated system to verify problems solutions sent by users.
7. A plain design of the information system.
8. A run-through the list of tops in the current contest and building up the total scorecard.
9. The bilingual information system (in Russian and English) provided for international contests.
10. The intuitive user interface for a wide variety of viewers.
11. A manual available for the information system.

The system under consideration consists of a number of large modules, required to ensure its continued operating process. The modules of the system include the following:

1. Contest management module. It functions in developing and editing the contest, as well as the problems of it.
2. Current standings module. It automatically generates a spreadsheet for each contest.
3. Authorization module. It stands for users’ registration, authorization, and log in one’s “Personal Area”.
4. Testing module. This is the major and largest module of the information system. It deals with verifying users’ solutions and the results of that checking up. It is suggested to link home page to the modules listed above (see Figure 1).

![Figure 1. Home page of the information system.](image)

When structuring the database in the information system for the programming contest, the main tables can be distinguished.
1. “Users” is a table of the users of the website. It includes in-fed information while registering, i.e. name, surname, patronymic, encrypted password, email, gender, date of birth.

2. “Contests” is a table for storing statistics of the contests held. It contains information on the name of the contest, date, run-time (start and finish), the type of the contest (individual or team), and the inventor of the contest.

3. “Problems” is a table for storing data about problems. It involves information on the problem name, its order number in the contest or in the problem list, the maximum run-time of the problem solution per second, the maximum memory for solving this problem in megabytes, problem text, information on input/output files, and samples of problem solving, the type of problem (competitive or independent), the number of tests to verify the users’ solutions, the inventor of the problem.

There are also supporting tables, such as:
1. “Userproblems” is a table for storing information on users’ problems solutions. It contains the user ID, problem ID, solution result type, attempt number, solution code, a compiler chosen for solution, the date and time of sending the solution.
2. “Usercontests” is a table for storing information on users’ participation in the contest. It keeps the user ID and the contest ID.
3. “Privilege” is a table of users’ bonus points. It consists of information on the name of the privilege, possible development, editing, and deleting problems or contests.

The structure of the database is presented in Figure 2.

**Figure 2. Project Database**

In the information system “Test Solver” designed, there are several users’ roles. They are an administrator, an inventor of the contest, a participant of the contest. Let us comment on an inventor’s
work. When developing a competition, the user needs to set up a time-limit. Later, the inventor gives a name to the contest in the form of adding a contest (Figure 3), start and finish, as well as the type of contest.

**Figure 3.** The contest addition form.

After the contest development, the user has to upload the problems using the conventional format in the community, i.e. ID or name, problem number, time and memory limits. The assignment is to specify a condition to a problem which is to be programmed in the easiest way. Then, the format of input/output data, and samples of tests to confirm the correct solution are indicated (Figure 4).

**Figure 4.** The problem addition form.
This system gives an opportunity to view all available problems on one web page. That is what makes it much more special in filling in problems. Thus, it provides ergonomics of the inventor of the competition. To complete the problem preparation, one needs to load pairs of tests. They are text files, from which direct data are taken to verify the solution. (Figure 5). Finally, the problem is ready to be involved in the contest. The validation of the problem components is made automatically when switching to editing a new problem. The whole process of filling the components is made by spoilers. Each element of it opens by clicking it or the proper button on the right.

![Figure 5. Adding tests](image)

After the contest had been developed, all users received information on a proper page of the information system (Figure 6).

![Figure 6. Contest page](image)

Let us comment on the participant’s work in this system “Test Solver” during the contest:
1. After registration and authorization on the site, the user can choose a contest from the list of them and take part in any available.
2. At the stage of starting the contest, the user has an access to the problems. The user can look through them and send his/her solution in any of the supported programming languages (C, C++, C#, Pascal, and others).
3. Each time the user sends his/her problem solution is registered and stored in the database. So, the user can follow his/her rank in the list of tops.
4. At the end of the contest, the access to the problem solutions is closed, and the user can check the total score.

3. Results and Discussion
The experiment to test the system “Test Solver” was carried out on February, 11th, 2018 during the programming contest called “Sprint Programming” in Sholom-Aleichem Priamursky State University. 11 students were the participants in that contest. 15 problems were loaded in the system. According to the similar ones, the system did not indicate those participants who had not sent any solutions in the contest. Figure 7 records the scores of the contest.

![Figure 7. Contest table](image)

In figure 7, problems that are not completed by the participant are marked in red, the completed ones are green, and those which were solved quickest are dark green. At the bottom of the table, statistics is displayed for each problem of the contest: the total number of attempts, the number of correct and incorrect solutions. The system has proved to be a functionally stable operating platform. There was no failure during the experiment. Six students are regular and the most active participants in such kind of contests in programming on various platforms. The survey showed that the updated system meets the users’ needs by both interface and accuracy.

4. Conclusion
To sum up, this kind of information system for conducting programming contests is a completed project and can be used in arranging similar events. However, the system “Test Solver” can be updated. It might add more flexible settings, the multi-stage leagues, implementation of system of points taking, including bonus ones. Also at the moment the software has tools for testing in C/C++, C#, Pascal. In the future, it is planned to add Python, Java.

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PC² programming contest control system – http://pc2.ecs.csus.edu

DOMjudge automated system for programming contests – http://domjudge.org

System ACMP for organizing programming contests – http://acmp.ru