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URI Online Judge Academic: A Tool for Algorithms and Programming Classes

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Abstract—**The URI Online Judge Academic is an online tool that assists professors in programming classes and motivates students to practice more and to go beyond the theoretical base learned in class and, as a result, helps them sharpen their logical, algorithmically and programming skills. The Academic module enables professors to manage disciplines and lists of exercises on specific programming topics in a visual and organized online environment that presents several benefits compared to the traditional method of handwritten lists. The purpose of this article is to introduce the features and the benefits available in version 3.0 of the tool.**

Keywords—programming practice; learning tool; online judge;

I. INTRODUCTION

Not that long ago, some of the authors used to evaluate his students using lists of handwritten exercises in order to force them to develop and practice algorithms outside the classroom environment. The correction of these lists was a time consuming task due to the large number of students and most important, the possible infinite existing approaches to solve any particular problem.

With the evolution of technology, professors are everyday seeking new and modern methods to present the theory in order to attract the attention of their students, as new generations are more active and are very reluctant to accept the traditional form of education. This led the authors to create a programming website named URI Online Judge, integrated with a second environment named URI Online Judge Academic.

The paper is structured as follows: In Section 2, we give an overview of the URI Online Judge website. In Section 3, we present the main features available in the URI Online Judge Academic and their potential to help both professors and students. Finally, in Section 4 we present some data about its use since it was released.

II. THE ONLINE JUDGE

URI Online Judge is an online platform developed in the Computer Science Department at Universidade Regional Integrada, Brazil and it was first introduced at WorldComp'12 [1]. The project aimed to create an online environment (Fig. 1) to assist both professors and students of Algorithms and Programming Languages. The motivation for this project

came from the need, observed by the authors, of new tools to complement the theoretical classes providing practical real-life problems where that theory could be applied.

Since its creation, the URI Online Judge has received several upgrades to include new and unique features that distinguish it from other online judges, the most important are:

- Categorization of problems (Begginer, Ad-Hoc, Strings, Data Structures and Libraries, Mathematics, Paradigms, Graph and Computational Geometry), allowing students to focus on specific topics.

- Integrated Toolkit, a feature that allows the students to generate the expected output for a problem for any given input.

- Visualization of source code directly in the browser window.

- Percentage of wrong answer, i.e. number of lines that present the incorrect output.

- Rewarding system (badges) to challenge and encourage students to use the tool with frequency.

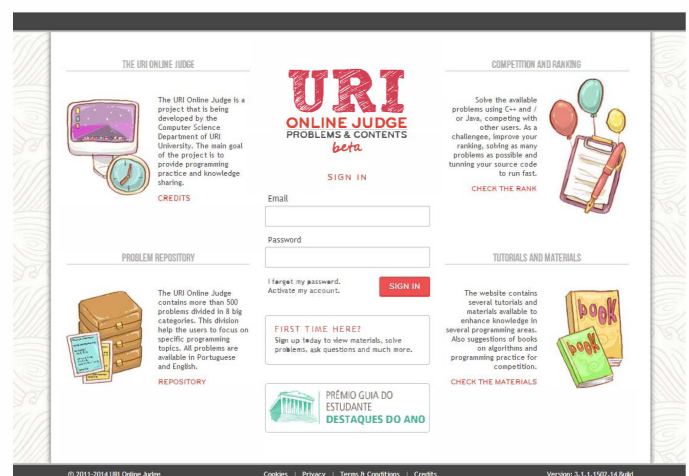- Integrated Forum for the students to discuss solutions

Fig. 1. URI Online Judge website

III. The Academic Module

Complementing the online judge platform, the URI Online Judge Academic, presented in [2], has released a unique system, for exclusive use by professors. This system helps them harvest all the power of the URI Online Judge website in Algorithms and Programming classes. The latest version of the system released new features that will be discussed in the next items.

A. Disciplines

The Academic module was re-designed using the same principles professors use to organized their classes. Using the "Disciplines" menu, a professor can create an infinite number of disciplines and invite students, i.e. URI Online Judge users, to participate in these disciplines. The discipline control interface (Fig. 2) makes easy for the professor to visualize the overall progress of a student taking into consideration all the list of exercises proposed.

B. Homework

Each Discipline can also have an unlimited number of homework (lists of exercises). These lists can contain up to 30 exercises selected from the URI Online Judge repository of problems. Besides the category, all problems have subjects (related topics) and level of difficulty (1-10). A professor also has the possibility to suggest problems of his/her authorship to be included in the tool. In version 3.0, a homework has several new features:

- Restriction of accepted solutions according to programming languages, i.e. the system will be able to consider solutions (source codes) only in C++, only in Java or both.

- Control the start date and the deadline of each homework.

- Control the visibility of the homework, allowing a professor to create all the necessary lists in the beginning of the semester and periodically release them;

- Integration with Moss [3] allowing professors to detect plagiarism among solutions. Moss (*for a Measure Of Software Similarity*) is an automatic system for determining the similarity of programs. Since it was release in 1994, its main application has been in detecting plagiarism in programming classes.

Fig. 2.   Discipline control interface

C. Monitor Progress

The most important procedure after creating and releasing a homework is to be able to track the progress of each student and identify the topics they are having a hard time understanding. The URI Online Judge Academic presents these data in a grid called Progress Table (Fig. 3). This grid uses the following convention:

- Green Box: the student successfully solved the problem passing on all the judge's test cases.

- Red Box: the student submitted a solution but it did not pass on all the judge's test cases.

- Gray Box: the student did not attempt to solve the problem yet.

Since a student may submit an infinite number of source codes while attempting to solve a problem, all the submissions between the start date and deadline will be available for the professor to visualize. By clicking on each box showed in the Progress Table, the professor will be able to see the student's Timeline related to one of the problems (Figure 4). This feature, available in version 3.0, helps the professor better understand where the student is making a mistake and his/her evolution over the time.

Fig. 3. Progress Table

Fig. 4. User's Timeline

D. The Academic and The Students

The URI Online Judge is completely integrated with the Academic module. The students have an interface at their disposal (Fig. 5) where they can visualize and monitor all the disciplines they participate and all the homework they have to do. As soon as a professor sends an invitation and the student accepts it, he/her will be able to start solving the problems.

Through the interface they can easily control the exercises they have to solve and the deadline of each homework (using Google Calendar) thus eliminating the need of printing or emailing their solutions to be corrected and analyzed by a professor. The system correct the solution in real-time providing a feedback and automatically it will be available for the professor to visualize the results. The possible answers any solution could receive is:

- Accepted;

- Presentation error;

- Compilation error;

- Runtime error;

- Time limit exceeded;

- Wrong answer (10% - 100%).

A great advantage about using the URI Online Judge in classes is that the students are not limited to the exercises selected by the professor. On the contrary, he has the entire repository of categorized problems to solve, allowing them to sharpen their skills on those topics with real time feedback (correct or incorrect solution).

It is important to notice that for privacy and security reasons only the professor, after his/her identity is verified, will have access to the system and only after receiving the permission of the student, he/she will be able to track their pupil's progress. No other student will be able to see the progress neither the solutions of his/her classmates.

IV. System Statistics

Since its first release in 2012, more than 180 disciplines and 480 homework (lists of exercises) were created. The number of professors who uses it in their classes, as well as the number of disciplines and homework has been growing steady since then.

More than 150 professors from different universities around the world use the URI Online Judge Academic in their classes using one of the following approaches:

- Obligatory lists of exercises;

- Complementary lists of exercises;

- Bonus points;

- Exercises database;

- Practical exams.

V. CONTESTS

Besides all the features available in the Academic module, the professor can also use the Contest module that allows the creation of open contests and private contests. For the open contests, the URI Online Judge team is responsible for creating and managing the contest and anyone can participate. For the private contests, a professor can include new and exclusive problems of his/her authorship to be used only during the time of the contest. In this approach only the students with an access key will be able to participate which makes the perfect alternative for practical programming exams. After the test, the professor will be able to assess each student.

VI. CONCLUSIONS

Although we are in the 21st century, several professors still use the traditional approaches to evaluate the students using handwritten lists of exercises. The URI Online Judge and the Academic module here presented suggest a different proposal. This proposal is likely to be more attractive to students because it allows them to have all their lists of exercises in an organized environment, with clear deadlines and with real-time correction. Professors, on the other side, can easily manage each discipline without the time consuming task of correcting each solution. The Academic module also allows him to track the progress of each student and intervene if a student is not able to solve the exercises, preventing the escape of students.

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