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# Kyrgyzstan Olympiad in Informatics: Training Students, Conducting the Olympiad and Using Contest Management System

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**Abstract.** The Article analyzes current state, problems, challenges, and opportunities of the Olympiad in Informatics activities in Kyrgyzstan. From the practical point of view, authors suggest mechanisms and instruments with a purpose of improving several main criteria of successful performance by Kyrgyz students at international informatics contests, including the most prestigious and respected one - International Olympiad in Informatics (IOI). One of the significant practical tools described and analyzed in the paper is the Contest Management System (CMS). CMS is an automated platform that allows not only to check and verify the solutions proposed by the contestants, but also optimize work and organizational processes of the olympiads at local and national levels. The authors suggest that further development of CMS will allow not only to increase the quality and efficiency of evaluating proposed solutions at the contests, but also improve overall performance of the Kyrgyz students at local and international olympiads in informatics.

**Keywords:** informatics, olympiad, training, grading system, contest management system.

## 1. Introduction

Olympiad in informatics of school students are conducted annually in Kyrgyzstan as well as in many other countries. Currently olympiads in informatics are organized on a four-round basis: 1) school, 2) district, 3) region (the cities of Bishkek and Osh have a special distinct status), and 4) national levels. The first and second rounds are carried out by local school teacher and are an open-call competition for all students, whereas the third and fourth rounds are prepared and organized by a National Commission.

A quota for certain number of participants is allocated for every round of the competition. However, there has been a common criticism that such an approach leads to having promising students dismissed at the early rounds before they make it to the regional

level. Certain schools or districts have traditionally had more talented participants than allowed by the quotas, which practically lead to having them replaced by weaker participants from other schools and districts.

In 2017 the third round of the olympiad in informatics hosted 158 students from 9 regions, whereas in the fourth round only 19 students remained (2 students from every region and a last year winner that participates directly in the finals skipping preliminary rounds). The map below illustrates 7 regions, the cities of Bishkek and Osh owning a regional status, and the number of participants from each region (Fig 1.)

Kyrgyzstan high school students are allowed to code using C++, Pascal and QBasic at olympiads in informatics. These programming languages are taught at Kyrgyz schools. Usually participants using C++ and Pascal succeed to make it to the final round. Unfortunately, it is yet impossible to exclude Pascal and QBasic because students in the regions currently cannot learn C++ and other contemporary programming languages at schools due to lack of qualified teachers.

For many years in Kyrgyzstan assessing olympiad tasks was carried out by a simple launch method. The programs were run with a manual input of data or test files, and the results were compared with initial data afterwards. Obviously this method is inadequate for manual verification results in a poor quality of assessment due to the following:

- Number of possible tests is limited.
- Size of input and output data is limited.
- Tests are time-consuming.
- Programs can be tested only at the end of the olympiads (lack of interactivity).
- Assessing programs can be compromised by inputting wrong initial data during program tests.


Fig 1. The number of a third round participants from each region of Kyrgyzstan in 2016–2017.

- Optimality of a proposed task solution (in terms of a program's performance duration and memory usage) is hard to evaluate.
- Task solutions are evaluated individually and subjectively (which may lead to corruption).

## 2. Problems and Improvement

Kyrgyzstan has participated in IOI since 2000. Kyrgyzstan's national teams haven't often demonstrated outstanding performances. The best result was achieved in 2005 (Table 1), whereas in other years Kyrgyzstan has always been at the bottom of the tournament table of IOI (International…, 2017).

One of the reasons of Kyrgyzstan's poor performance at the IOI contests is a decline in quality of education and economy that was partly triggered by 2 consecutive revolutions in 2005 and 2010.

The attitude to olympiad movement started to change from 2015 on, and Kyrgyzstan began to cooperate with neighboring Kazakhstan and Russia in preparing students for the IOI contest. Kyrgyz students attended summer schools: in Almaty, Kazakhstan, in 2015 and in Innopolis (Tatarstan, Russia) in 2016. This year they have applied to the Summer Computer School in Kostroma, Russia.

Kyrgyz students have started demonstrating better results in different contests in informatics. In APIO (Asia Pacific Informatics Olympiad) they received honorable mentions, whereas in IZho (International Zhautykov Olympiad) Kyrgyzstan participants usually get gold, silver, and bronze medals. In All-Russian olympiads in Informatics for school students Kyrgyzstan's team got diplomas of 2nd and 3rd degrees.

Development and growth of information technologies and internet, which allow learning and training for any contest based on various online grade systems, create ground for assisting the olympiad movement. Russian websites like acm.timus.ru, codeforces.com, acmp.ru, and e-maxx.ru, Ukrainian website like e-olymp.com as well as international sources like csacademy.com and usaco.org are very popular resources among Kyrgyzstan students. A similar Kyrgyz website olymp.krsu.edu.kg was made for conducting college student olympiads according to ACM ICPC rules and regulations. Currently this website is being used for conducting regular local informatics contests for high school students as well as for learning and training.

Table 1

The best results of IOI (period 2000-2015)

| Year | Contestant | Score | | Rank | |
|---|---|---|---|---|---|
| | | Abs. | Rel. | Abs. | Rel. |
| 2005 | Igor Goroshko | 319 | 53.17% | 110/276 | 60.51% |
| 2004 | Aleksey Baryshnikov | 265 | 44.17% | 143/291 | 51.2% |
| 2000 | Andrey Mokhov | 250 | 35.71% | 129/278 | 53.96% |

Moreover, improvement in selecting participants for IOI has appeared. An automated Contest Management System has been used at the 4th stage of the olympiad since 2015. The system had been developed and was successfully applied in Kyrgyzstan at high school olympiad that had a more flexible IOI-standard task evaluation system compared to that of college student olympiads.

Overall, an approach to olympiad in informatics has changed in following direction:

1) Integrating an automated Contest Management System.
2) Having students to attend Preparatory Schools for Informatics Olympiads.
3) Intensive self-study by enthusiastic students.

Abovementioned techniques resulted in better performance of Kyrgyz national teams on IOI and Kyrgyz students rose from the bottom of the result table. Ranks of Kyrgyz students on IOI from year 2011 to 2014 demonstrated negative dynamics, whereas performances in years 2015 and 2016 progressed prominently (Fig. 2). On IOI-2016 (Ka-

Table 2

Rank of Kyrgyz students on IOI (2011-2016)

| Year | 1 student | 2 student | 3 student | 4 student |
|---|---|---|---|---|
| 2011 | 12,87% | 14,85% | 16,83% | 22,11% |
| 2012 | 13,23% | 17,74% | 21,61% | 26,13% |
| 2013 | 8,36% | 14,05% | 14,38% | 28,43% |
| 2014 | 2,89% | 9,00% | 10,61% | 15,43% |
| 2015 | 13,04% | 25,78% | 35,09% | 44,10% |
| 2016 | 21,43% | 25,32% | 42,53% | 51,95% |

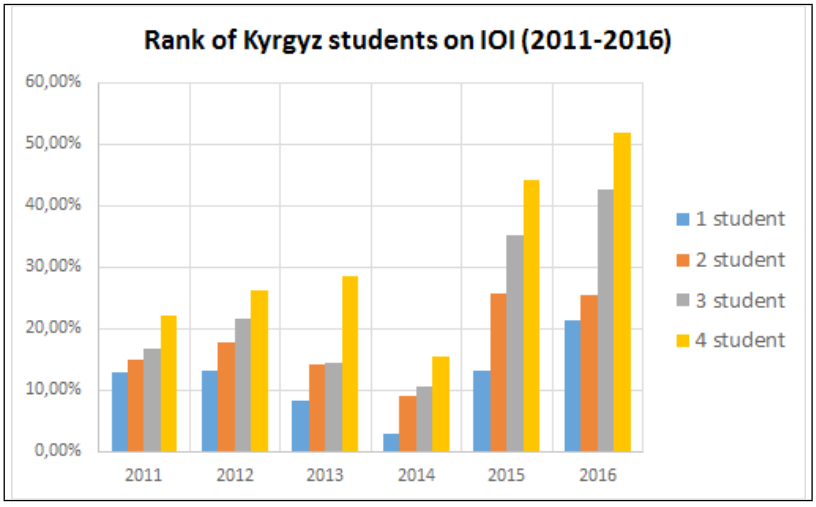


Fig. 2. Rank of Kyrgyz students on IOI (2011–2016).

zan, Russian Federation) Azret Kenzhaliev won a bronze medal to be the first winner from Kyrgyzstan in an 11-year-old break.

Alumni of our university and former participants of IOI are providing great assistance in developing and improving an automated Contest Management System, as well as preparing tasks for student contests.

## 3. About Contest Management System

Development of the Contest Management System began in 2014 at the Software Engineering Department of Kyrgyz State Technical University. Due to an urgent need of introducing an automated task evaluation system, the CMS was piloted in the 3rd round of the high school Olympiad (on a region level) in Bishkek in February 2015. The pilot launch of the automated system was then completed in the fourth round of the olympiad in national finals in March 2015. Updated versions of the Contest Management System were successfully applied in all rounds of Olympiads in 2016 and 2017.

CMS is written in Python with use of Django framework. MySQL is used as DBMS.

CMS used in Olympiads in Kyrgyzstan was then implemented into a web application. The application has a 3-level architecture. User's web browser - whether it's on PC, mobile or tablet - is used as a client. uWSGI functions as an application server (`https://uwsgi-docs.readthedocs.io/en/latest/`) and manages the application in Python/Django. Nginx (`https://www.nginx.com/resources/wiki/`) is used as a web server.

Direct interaction between the client and the database server is obviously unacceptable. Therefore, any interaction is possible only via application server. Detailed description of the system architecture is given in (Makieva, 2016; Makieva, 2016a).

Task description is provided in two languages because Kyrgyz is the state language of Kyrgyzstan, whereas Russian is official. All the design, management element captions and the system is menu are given in 3 languages: Kyrgyz, Russian, and English.

The system has 2 modes of task evaluation: IOI standard for managing high school student Olympiads and ACM standard for managing college student olympiads.

Testing programs developed by the Olympiad participants is automated. Therefore, the programs have to match the formats of input and output data described in every given task. Time and memory limits are set for the programs in every given task. As the participants finalize their programs, they can send their solutions for check. Once the system has checked the solution, the participant sees the testing result table on the screen with standard messages: Compiling, Proceeding, Compilation Error, Runtime Error, Time limit exceeded, Wrong Answer, and Accepted.

The system supports various types of task evaluation and checking. The process is implemented with program checker. There are 4 types of checkers:

1) **Exact answer**: there can be any amount of data in the answer, but their order and value have to be an absolute match.

2) **Answer with given precision** is used to check tasks whose answer is one or more real numbers. The system checks whether an absolute or relative error in the participant's answer does not exceed an allowed error margin.
3) **Multiple correct answers** are usually used for tasks that may have more than one correct answers. A well-known "8 Queens" chess problem or a search of a maze exit are examples of a task with multiple correct answers.The checker writes down the solution verification results into a special file, which the testing system then uses to check the solution.
4) **Interactive problems:** The interactor program can process conclusion of the participant's solution to the standard input stream and can also submit its data to the entrance of participant's solution using program's standard stream. Once communication is completed, the interactor writes the result to a special file that the system uses to display the result.

The system supports such programming languages as C++, Pascal and QBasic. Other languages can be added to the system if necessary.

Automated verification system provides following opportunities:

- To use large amount of tests - up to dozens of test per each problem, which increases reliability of problem checking.
- To process large amounts of input and output data, which allows to check performance of the tested algorithm with large sets of numbers (up to $10^9$ elements) and long strings.
- Checking and verifying a task is processed within several seconds depending on the number of tests. It allows performing an interactive check: a participant sends the program for check and can see the evaluation result till the end of the Olympiad, thus, having an opportunity to make changes to the proposed solution.
- Chances for errors at input or check are eliminated.
- The algorithm can be checked for optimality by analyzing time and memory it requires to work.
- All the results - including source code of the solution, time the program is sent, number of generated tests, etc - are saved to and stored in database on a single server.
- Reports with contest results are generated in a shorter periods of time.
- A large archive with test problems and solutions can be stored and used for learning and practicing.

## 4. Conclusion and Future Work

Application of an automated Contest Management System resulted in improving the quality of program check and, thus, resulting in a better preparation of high school students, as well as selecting the best contest participants by objective criteria.

From 2018 on it is planned to apply the CMS in the 3rd round of the high school contests, which will allow to select best contestants from the regions of Kyrgyzstan and

see the an overall rank of all the contestants on a national level. Also this will allow to increase the possible number of contestants in the 3rd round throughout Kyrgyzstan.

Moreover, for the purpose of developing the olympiad movement and improving preparation of high school students for the informatics contests State Methodical Commission of the Kyrgyz olympiad in informatics has recommended to do the following:

- Oblige secondary school teachers to attend refresher courses.
- Teach secondary school students programming languages of C++ and Pascal and exclude QBasic and Pascal ABC from the curriculum, to be able to participate in international informatics contests.
- Set the 5th grade at schools as the latest year to introduce informatics into the curricula and to continue teaching till 11th grade inclusively.
- Remove any age and year of study limitation at the national informatics contest in order to maintain a maximum coverage of school students.
- Use the automated Contest Management System at the informatics Olympiads in 3rd and 4th rounds throughout the country.
- Create an official website of national high school Olympiad with an automated solution checking system for students to be able to practice before the Olympiad.

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