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Japanese Olympiad in Informatics

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Abstract. The Japanese Committee for the IOI (JCIOI) is a nonprofit organization and one of its purposes is promoting the interest of Japanese secondary school students in computer science as well as computer programming through various activities including Japanese Olympiad in Informatics. This article describes the process of selecting and training the Japanese IOI team and the key issues that faces JCIOI.

Key words: olympiad in informatics, training, programming competition, IOI, International Olympiad in Informatics.

1. Introduction

The Japanese Committee for International Olympiad in Informatics (JCIOI) started the Japan Olympiad in Informatics (JOI) in 1994 and sent Japanese delegations to IOI 1994 (Sweden), IOI 1995 (Netherland) and IOI 1996 (Hungary). Unfortunately, due to financial difficulties, the activities of the JCIOI were suspended from 1997 to 2004.

When the JCIOI attempted to restart its activities, the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) decided to support school children participating in international science and technology contests including the IOI. This decision efficiently provided enough support needed to reinstate the JCIOI. The aim of MEXT is to encourage talented school students to take more interest in and orientation toward science and technology, through competitions and exchanges with other children of the same generation throughout the world.

At the time of reinstatement, Japan did not participate in any international science olympiads, except for the International Mathematical Olympiad. Consequently, the JCIOI was reorganized as a nonprofit organization sponsored by the Japan Science and Technology Agency (JST), an independent administrative agency affiliated with MEXT. In 2006, the JCIOI sent the Japanese delegation to the IOI 2006 (Mexico) for the first time since 1996.

In the two years of participation at the IOI, the Japanese Team won three gold, one silver and two bronze medals. Based on these unexpectedly good results, the IOI contestant selection procedure has been deemed successful. However, a certain number of issues remain to be resolved. One such issue concerns the quality and quantity of computer science education for younger students. Another issue is related to the fact that students possess adequate skills in either programming or mathematical reasoning, but not both.

The goal of the JCIOI is to improve the abilities of the students gifted in computer science as well as the overall population of secondary school students. The JCIOI also aims to generate greater interest in informatics in secondary schools. This article will outline some ways in which the JOI can achieve these goals. The paper is organized in the following way. Section 2 introduces the Japan Olympiad in Informatics and the IOI contestant selection procedure. Section 3 discusses key issues and future works. Section 4 shows the conclusions.

2. National Olympiad in Informatics and Selection of IOI Contestants

2.1. *Structure*

Activities of the JCIOI were restarted in 2005. That year, the JCIOI sent observers to IOI 2005 in Poland and held the first round of the Japanese Olympiad in Informatics (JOI) 2005/2006. At the present time, the JOI attendance fee is free because of the support of JST. While the committee works to improve the domestic olympiads, JOI has maintained a simple structure due to personnel, budget, and time constraints.

The JOI has two rounds. The first round is an open online programming contest, with the tasks provided only in Japanese. Students who qualify are invited to the final round which is held at a central location in Tokyo, so contestants from all over Japan are gathered at one place. The top students of the final round are awarded gold, silver or bronze medals according to their grades. The JCIOI invites students who perform well in the final round of the JOI to a training camp. The IOI contestant selection takes place at the training camp. The Japanese team for the IOI, along with other camp participants, continues the training process through correspondence from the end of the camp until the moment of departure for the IOI. The expense for travel to IOI is covered by JCIOI via JST aid.

2.2. *First Round of JOI*

The first round is usually held on a Sunday in December. Participants have to solve six tasks with the programming language that they wish to use for three hours. Five test data per task are distributed in the beginning of the contest and contestants have to upload the outputs for the test data. The grade of a participant is automatically decided based on the number of correct outputs uploaded. One of the objectives for adoption of such a system is to allow the highest number of contestants possible to enter the competition. Due to the

disparity in the level of ability, four of the tasks are relatively simple, while the remaining two require more challenging mathematical and algorithmic considerations.

The number of participants of the first round at JOI 2005/2006, 2006/2007 and 2007/2008 was approximately 80, 150 and 280 respectively.

2.3. *Final Round of JOI*

The final round of the JOI is an on-site programming contest. It is time constrained and the contestants are required to design efficient algorithms and to implement them appropriately. The most difficult tasks of the competition are intended to be as difficult as the least challenging IOI tasks.

The final round takes place in an examination venue in Tokyo on a holiday in February. Contestants from all over Japan meet at the site and the traveling expenses are covered by the JCIOI. The JCIOI invites high scorers of the first round who are under 20 years of age on the day of the final round and secondary school students, excluding high school seniors. Note that students usually graduate form high schools at 18 years of age in Japan. From JOI 2007/2008, top ranked students in each region are also invited to the final round. The numbers of students who proceeded to the final round at JOI 2005/2006, 2006/2007 and 2007/2008 were approximately 30, 40 and 50 respectively.

Five tasks were proposed to contestants, to be solved for three hours in JOI 2005/2006 and 2006/2007. The duration of the contest has been extended to four hours since JOI 2007/2008. For each task, contestants have to write programs in C/C++ or Java that solve the task and to submit them. Contestants are provided sets of sample inputs and corresponding outputs in order to confirm whether their solutions satisfy the output format and to assist in estimating the running time of their programs. After the examination, the submitted solutions are compiled and run with test data unknown to the contestants on an evaluation machine. The specification and the programming environment of the evaluation machine are the same as the machines used by contestants in the final round. The participant's grade is automatically calculated by the number of test data for which their solutions output correct answers within the time limits. The test data are set as distinguishing efficient solutions from inefficient solutions.

2.4. *Training Camp*

The training camp starts March 19th and ends March 25th every year. The JCIOI invites top ranked students from the final round of the JOI. The number of camp participants at JOI 2005/2006, 2006/2007 and 2007/2008 was 8, 13 and 16 respectively. In addition to IOI contestant selection, four lecturers are also invited to speak at the camp. These speakers include university faculty members, graduate students, and IT professionals. Table 1 sketches the schedule of the JOI 2007/2008 training camp. During the camp, former IOI contestants and ICPC contestants work as tutors. They communicate with the participants and support in organizing the camp.

The camp competitions are held in IOI competition format. Three tasks are set at each competition. The twelve tasks are intended to cover as many IOI problem types as

Table 1
The schedule of the JOI 2007/2008 training camp

March	Morning	Afternoon	Evening
19th		Arrival	Practice Session
20th	Competition 1 (3 hours)	Lecture 1	Comments and Discussion 1
21st	Competition 2 (4 hours)	Lecture 2	Comments and Discussion 2
22nd	Competition 3 (4 hours)	Lecture 3	Comments and Discussion 3
23rd	Lecture 4		Free Time
24th	Competition 4 (5 hours)	Awarding Ceremony Public Lecture	Comments and Discussion 4 Farewell Party
25th	Departure		

possible. The difficulty of the last competition is similar to those of the IOI. Almost all tasks are batch tasks, with a few being reactive and/or output-only. For tasks requiring source codes as solutions, C and C++ programs are accepted. The top four students are selected to represent Japan in the IOI.

Two of the lectures are focused on the design and implementations of efficient algorithms. The other lectures deal with topics that are not directly concerned with programming contests. For example, an introductory lecture for theoretical computer science is provided. The titles of lectures at JOI2007/2008 were as follows:

- Let's try to use STL;
- An introduction to computational complexity theory
  – Get a million dollars to solve the "P = NP?" problem;
- An introduction to information retrieval
  – Algorithms for Web search engine;
- Let's solve IOI problems with a functional programming language.

At the present time, the camp schedule is completely full. The IOI participant selection, programming contest ability improvement seminars, and computer science motivational presentations account for the full schedule.

2.5. *Correspondence Course*

After the training camp, a correspondence course starts for the camp participants, including the members of the Japanese IOI team. The participants solve problems from past IOIs and regional informatics olympiads, after which they submit their solutions to the team leader of Japan. After the deadline set for each task, the submitted solutions are posted on the course bulletin board system. Participants exchange views on submitted solutions for two weeks and the coordinator of each task gives them suggestions and summarizes the discussions. If a participant submits a solution after the deadline, the coordinator will post comments about the solution on the bulletin board system.

2.6. *Task Creation*

The scientific committee (SC) of the JCIOI controls the entire process of creating JOI tasks from the first round through the training camp. The SC attempts to maintain a balance between suitable qualifier selection and participant satisfaction. The steering committee of the JCIOI appoints the members of the SC. Initially the SC consisted only of faculty members when the JCIOI resumed activities. However today, former IOI contestants and ICPC contestants are involved in the SC.

The deliberations on task creation are held both at off-line meetings and on the bulletin board system for the SC. For JOI2007/2008, the off-line meetings were conducted ten times and approximately 400 messages were posted on the bulletin board system. Subversion, a version control system, has been used to maintain tasks, test data, solutions, commentary, etc. SC members commit drafts of their tasks to SC's Subversion. A task set for a contest is chosen from a pool of tasks stored on the Subversion that meets conditions relative to difficulty, area and type. If there are an insufficient number of tasks, the SC will create new ones.

3. Key Issues and Future Works

In the previous section, the IOI contestant selection procedure was mentioned. Currently, the procedure in place appears to be successful in choosing appropriate candidates. IOI contestant selection is not the only goal of the JCIOI, however. The aims of the JCIOI also include improving the abilities of the students gifted in computer science, as well as generating greater interest in informatics in secondary schools. At JOI 2005/2006 and 2006/2007, only IOI contestant selection and IOI participation training were held due to personnel, budget, and time constraints. Recently, the JCIOI situation has been improving. Evidence of this is as follows:

- the number of faculty members and former contestants who have joined the JCIOI continues to increase each year;
- in 2007, the JST began to support the promotion of sciences including computer science in secondary schools in addition to hosting domestic science competitions and sending Japanese delegations to international science competitions;
- Fujitsu Limited has supported the activities of the JCIOI since 2005. Since April 2008, NTT Data Corporation has started to sponsor the JCIOI.

Hence, the JCIOI has initiated new activities to achieve its aims. The remainder of the section will address two of these new activities, as well as the remaining challenges to be faced.

3.1. *Summer Camp*

M. Forišek mentioned in (Forišek, 2007): "We strongly believe that the thinking process (in other words, the problem solving process) is the most important skill we want to see in

our contestants. This is what they will need in their future lives, should they pick a career in computer science." The JCIOI agrees with Forišek's theory. The JCIOI considers the most significant challenges of the IOI competition format to be the following:

- a lack of consideration for the thinking process when grading solutions;
- a lack of open-ended problems to challenge higher level students;
- excessive focus on the importance for quickness when completing tasks;
- excessive focus on the importance for coding skills.

A student who produces an excellent solution, but is unable to submit it within the contest time frame will unfortunately not receive any points. The students who are able to solve all IOI tasks in five hours and five minutes seem to be as outstanding as ones who are able to solve the tasks in five hours. Every IOI task is capable of being solved in two hours or less. At the current time, the IOI and the JOI have implemented regulations that are biased towards students who are better able to write code and finish tasks quickly. These regulations regrettably neglect the thinking process needed to succeed in the field of computer science in the future. If the regulations are changed, another bias would undoubtedly be created as a result. Therefore, in 2007 the JCIOI has started a summer camp that does not include any competitions.

The camp is held for three or four days soon after IOI in late August. Approximately 20 students including past JOI training camp attendees participate. At the first camp last year, a faculty member gave a lecture about computability theory. In addition to that, the camp participants were divided into small groups and each group studied a computer science text book for undergraduate students. Each group gave a presentation about what they learned on the last day. The style of the summer camp may change in the near future.

3.2. *Introductory Course of Computer Science*

In Japan, computer science is absent from the secondary school curricula at the present time. In order to promote it in secondary schools, elementary educational materials should be provided to them. The first step in the realization of this goal is to develop a web site that introduces computer science to young people. This will be done in cooperation with Fujitsu Limited and an educational group to promote "Computer Science Unplugged" (Bell *et al.*, 2002; Kanemune *et al.*, 2007). Fujitsu Limited operates a web site for children. They plan to add an introductory course of computer science at the Fujitsu's kids site in the near future (Fujitsu, 2008).

3.3. *Future Works*

Besides JOI, a few other programming contests for secondary school students are held in Japan. The Supercomputing Contest (SuperCon) is a programming contest for high school students using a supercomputer system at the Tokyo Institute of Technology and/or Osaka University. SuperCon is a team competition, in which teams create a program to solve a given open-ended problem. Unlike the IOI and the JOI, there is no rigid time limit. Teams compete with their ideas and originality to design algorithms to solve a problem

for three or four days. One of the reasons why the Japanese team achieved positive results so quickly upon returning to the IOI is that Japanese students have been competing in SuperCon since 1995. The contest is usually held at the beginning of August. It is a great advantage to have competitions that are held in different seasons and differ in contest format. Therefore, the JCIOI does not intend to hold another contest for top ranked students at the present time.

However, it is necessary to hold contests for students who have little experience and/or are not very familiar with logical thinking. If students without adequate coding skills attend the JOI, their participation will be limited. The JCIOI realize the necessity of "theoretical" or "logical" (by pen and paper) tasks that many national information olympiads adopt. The theoretical or logical tasks are expected to play a key role in improving interest in computer science among secondary school students and teachers. In the first Olympiads in Informatics Conference, there were many fruitful discussions about the running and issues facing several national Olympiads (Dagienė *et al.*, 2007). Especially, the procedures of Brazil (Anido and Menderico, 2007), Italy (Casadei *et al.*, 2007) and Slovakia (Forišek, 2007) have been helpful for the JCIOI. In response to growing needs for logical thinking, the JCIOI has started to prepare a new contest without coding.

There are a lot of challenges facing the JCIOI. The committee intends to address each issue one by one. Possible solutions include cooperation with secondary schools and training secondary school teachers.

4. Conclusions

In this article, the activities for the Japanese Olympiad in Informatics and the IOI contestant selecting procedure have been presented. Some issues and future works have also been described. The main challenges involve providing theoretical background and promoting initiative to generate interest in computer science in secondary schools. The JCIOI will continue to improve its activities to make computer science popular and to encourage gifted secondary school students to be interested in it.

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