IOI Israel – Team Selection, Training, and Statistics

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Abstract. We outline Israel's IOI (International Olympiad in Informatics) project. Israel joined the IOI in 1997 and has participated in the IOI ever since, apart from 2008. We describe the selection and training process in Israel, and provide some statistics. The selection and training process is composed of four stages: a self-study preparation; a national competition, an advanced training and team-selection stage; and the national team's preparation to the IOI. The presented statistics involve Israel's medals throughout the years, and some statistics about the top 30 students, who reached the advanced training and team-selection stage.

Key words: programming contests, IOI.

1. Introduction

The IOI – the International Olympiad in Informatics – is the primary computer science (CS) competition for young students, up to the age of 20. The IOI is one of six annual international youth olympiads, including: the IMO in mathematics, the IPHO in physics, the ICHO in chemistry, the IBO in biology, and the IAO in astronomy. The IOI is hosted every year by a different country. It started with 13 participating countries, in Bulgaria in 1989, and expanded to 80 countries today.

The primary goal of the IOI is to stimulate challenges in CS among exceptionally talented young students from all over the world, and have them share scientific and cultural experiences. Each participating country conducts a preparation process, and brings an IOI team, which includes four contestants. In the IOI, the contestants compete individually in the course of two competition days, each involving three challenging algorithmic tasks, to be solved and programmed.

The task solutions require careful task analysis, insightful correctness and efficiency considerations, and skilful programming implementation. Creativity, competence in algorithmic topics (Verhoeff *et al.*, 2006), and implementation accuracy are essential. The better half of the students in the two-day competition win gold, silver, and bronze medals.

Different countries invest different amounts of effort and resources in preparing their IOI teams (e.g., Diks *et al.*, 2007; Casadei *et al.*, 2007; Forisek, 2007; Kolstad and Piele, 2007), yet the preparation outlines seem similar. A call-for-participation engages an initial amount of interested students, from whom the top ones are chosen, through a selection and training process. In what follows, we briefly describe the selection and training process in Israel, and then display some statistics of this process and of Israel's participation in the IOI.

2. The Selection and Training Process in Israel

In Israel, the IOI project is operated and supported by Tel-Aviv University, the Open University of Israel and the Ministry of Education. The primary objective of the project is to offer challenges in CS to motivated students, who show interest and competence in problem solving in general, and algorithmic problem solving skills in particular.

The project is composed of four stages: a self-study stage towards a national competition; a national competition, an advanced training and team-selection stage, and the national team's preparation to the IOI. The different stages are operated by a small training team, of five to six trainers – the head coach and his deputy, a couple of high-school teachers, and a couple of former IOI contestants.

The 1st stage is conducted in the beginning of winter. It starts with a call-for-participation sent to high-schools and posted in the national CS teachers' website (maintained by the high-school CS inspector in the ministry of education). Then, some of the project trainers (the head coach and the former IOI contestants) lecture about the IOI project in different high-schools and learning centers of talented young students. The interested students are referred to the project's website (`http://www.tau.ac.il/~cstasks`), and are encouraged to prepare to the national competition, by self-studying rather basic programming and data-structure constructs (e.g., recursion and trees) and solving previous national competition tasks.

The 2nd stage is conducted in the late winter (February). It involves the national competition, which is a three-hour exam, with pencil and paper. The students are gathered together, and are asked to solve four algorithmic tasks, and provide a written description of their solution idea and their solution code, or pseudo-code (according to their preference). The goal of the exam is to identify the students that demonstrate the highest potential, primarily in problem solving. Thus, the CS knowledge required at this stage is relatively basic.

The first task of the national competition usually requires recursion, which may be implemented with a rather simple dynamic-programming scheme. The second task involves a mathematical game, or a similar task, whose solution is based on a hidden invariant property. The third and fourth tasks are more involved, in terms of the required insight and the solution scheme. Yet, the code required for each of the tasks is rather short. The students are explicitly directed to focus on task analysis, and carefully notice correctness and efficiency considerations. In grading their solutions, we particularly examine their

creativity, accuracy, and scientific discipline. We pay less attention to detailed programming features, as long as the criteria indicated above are met.

The amount of students taking part in this stage diverts between the years, from about one hundred to several hundreds (see next section). We select the best 30 students, plus possibly a few additional ones, in cases where there are females or students from remote schools that are close to the top 30. All these students are invited to the next stage. Although only a small amount of students advance to the next, 3rd stage, our experience shows that the vast majority of students enjoy the challenge of the competition, and many return a year later, following some better preparation.

The 3rd stage is conducted in the spring. Our objective in this stage is to teach the top 30 students more advanced algorithmic and problem solving features, and test them about these features. The top four students of this stage are chosen to the national team. This stage involves 5–7 practice days (one or two such days a week). It does not involve a camp (as offered in some other countries), but rather a day gathering in a computer lab, due to our limited resources.

Each practice day lasts 8–10 hours. Prior to that day, students are asked to study particular topics (e.g., basic graph algorithms). In the first part of the day, they are posed with three algorithmic tasks to program in five hours, which involve the indicated topics and the previous days' topics. The students are asked to both program their solutions and write on paper their solution's underlying idea. At the end of this activity each student is interviewed about his/her solution. Our goal in the interviews is to examine their insight and extract potential errors and difficulties that arise and recur. In addition, the student programs are tested on diverse test-cases.

Following the interviews and the program evaluations, all the participants are gathered for a two–three hour discussion on the day's task solutions and their related CS topics. The discussion involves particular focus on insightful analysis, common errors, and essential efficiency considerations. The latter is particularly underlined, as many of the posed tasks may be solved in several ways, of different time and space complexities. We strongly emphasize two elements: potential and recurring errors, and algorithmic and problem solving features used in the day's task solutions, which are relevant beyond these tasks (e.g., particular task representations and illuminating perspectives). Some of these elements are described in papers and columns of the third author of this paper (e.g., Ginat, 2001; 2003a; 2003b; Ginat and Hasty, 2007).

At the end of the practice day, the students are asked to: program at home alternative solutions that were discussed, and further study the algorithmic and problem solving features that were examined. At the end of these 5–7 practice and evaluation days, we select to the national team the four students that demonstrated the best accumulated performance, in both algorithmic problem-solving and programming. The rest of the students are encouraged to return in the following year and convince other students from their schools to join as well.

The 4th stage is conducted thereafter and usually lasts up to two months, until the IOI. In this stage, the team is directed to learn and practice the topics relevant for the IOI, solve previous IOI and additional olympiads tasks, and thoroughly practice the programming

features required in the IOI. The team members meet with the project trainers once every one or two weeks, practice task solutions, discuss solutions, and receive advice and tips from previous team members who competed in the IOI. A particular emphasis is put on one's selection of test-cases before submission. The teams' record throughout the years is described in the next section.

3. Some Statistics

3.1. *Medal Distribution*

Table 1 presents the numbers of gold, silver and bronze medals received by the Israeli team since 1997, excluding 2008, when Israel did not participate. The four gold medals were earned by four different students.

3.2. *Participation in the National Competition*

The number of students who participate in the national competition varies from year to year, ranging from 40 (in the 1st year) to 507 (Fig. 1). These students come from approximately 20 to 70 different high schools located all over the country.

3.3. *The Top 30 Students*

Following the national competition, the best 30 students are selected for the next, advanced stage. These students come from 59 high schools located all over the country. Fig. 2 shows the distribution of the students among 30 high schools from which more

Table 1

Achievements of the Israeli team in the IOI

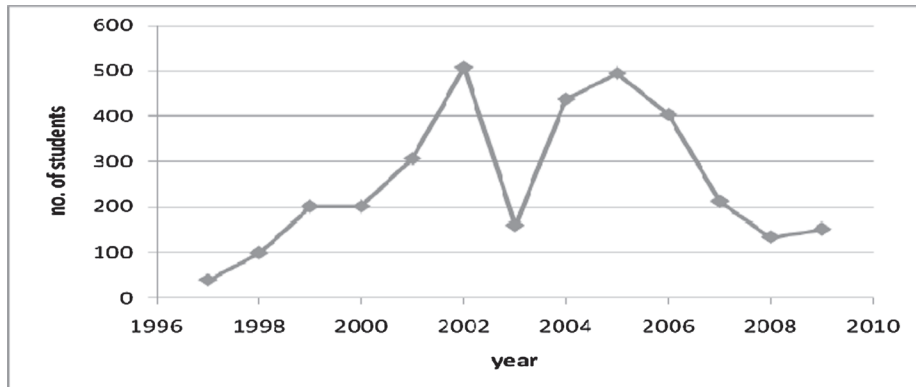| Year	Gold medal	Silver medal	Bronze medal
1997	–	2	2
1998	–	2	2
1999	–	1	1
2000	1	2	–
2001	1	1	1
2002	1	–	2
2003	–	1	–
2004	–	1	3
2005	1	2	–
2006	–	–	3
2007	–	4	–
2009	–	–	1
Total	4	16	15

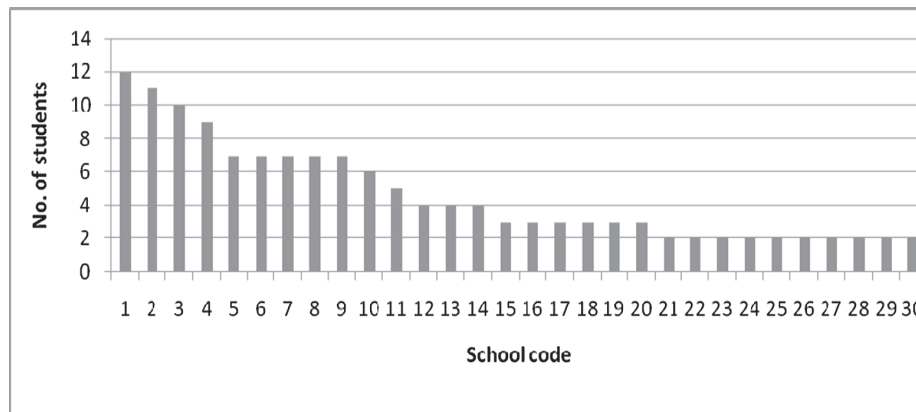Fig. 1. Number of participants in the national competition.

Fig. 2. Top 30 students – school distribution.

than one student was selected in the years 2004–2009. The rest of the 29 high schools had one student who made it to the top 30.

From Fig. 2 we can see that the best students are concentrated in a relatively small number of high schools. 50% of the best students come from 17% of the high schools. Fig. 3 shows the geographical distribution of the students among the different high schools in the years 2004–2009.

One can see that about 60% of the students come from the center of the country. An interesting fact, not in the figures above, is that in all the twelve years of the IOI activities in Israel only one female student entered the top 30 student group, in 2009. This female was actually among the top 8 students. Unfortunately, although she was very competent in algorithmic problem solving, she was less able in programming and solution implementation. Another interesting anecdote is that all our four gold medalists came from schools that do not have many representatives among the top 30 students.
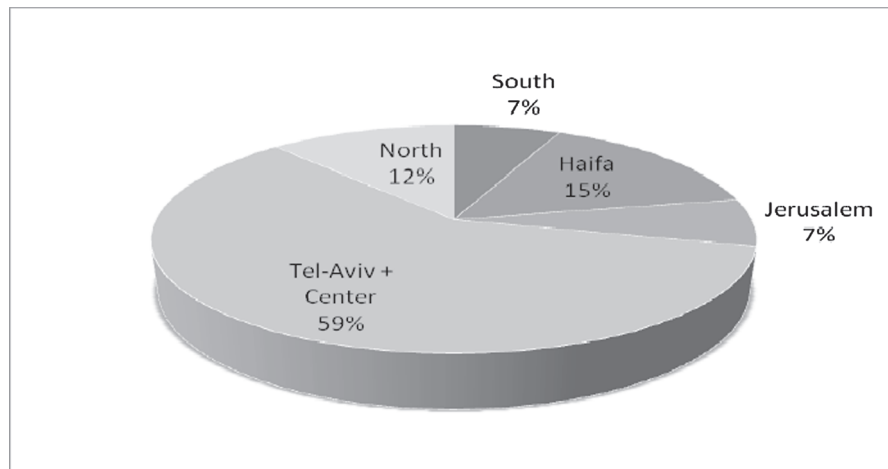
Fig. 3. Top 30 students – geographical distribution.

All in all, the IOI project in Israel is rather modest. Our hope is to extend our resources and activities in the coming years, expand our training team, hopefully with additional IOI veterans, and attract a larger number of interested students (males and females) already in the early stages.

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