Olympiads in Informatics, 2017, Vol. 11, Special Issue, 3–10

DOI: 10.15388/ioi.2017.special.01

Three Decades of International Informatics Competitions : How did IOI Start

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1. Informatics Competitions: Who Wins?

People are used to judge of the degree of development of a country by its gross domestic product, industrial indicators, agricultural output, the level of cultural life, stability of the political system and so on. However, if you ask 'What is the most important factor that drives up all these things?' you would inevitably realize that this is the human factor. Behind any significant achievement there are talent, high professionalism, devotion, perseverance, leadership. Talent, skills and personal characteristics as these are a decisive resource for the development of the society. Surely, natural resources (oil, gas, ores), even if not detected and used today, remain stored for future generations. However, abilities, talent and potentially fruitful personal characteristics of today's young people disappear forever, if not found, developed and used in time. The competitions (of any kind) help identify talent and develop personal characteristics which play an important role in any achievement.

The state of the art in any social sector and its potential for development depend heavily on how many bright young people are attracted to it. A distinguished characteristic of our time is that the digital technologies (DT) penetrate (and even invade) all aspects of social life. This is why the attraction of high quality human resource to DT becomes important for the sustainable development of the whole society. Competitions in informatics contribute significantly in this respect. Very often the participation in a competition predetermines the future professional realization of a young person. The first success (and sometimes even the first failure at a competition) motivates for further efforts which, sooner or later, brings success and this steers the young persons to professional realization in the field of DT.

For many people the competitions are just a tool to identify the best performers. What is often overlooked is the fact that the competitions bring benefits to all participants, not only to winners. In the process of preparing for the competitions and even during the competition all participants increase their skills and knowledge significantly.

Informatics competitions cultivate algorithmic and computational thinking which is increasingly gaining importance in all areas of human activities. Taking into account that hundreds of thousands of young people participate in competitions, the integral effect on the general knowledge in this area becomes apparent. It wouldn't be an exaggeration to claim that informatics competitions today are an integral and essential part of the global educational process which is no longer limited only to the classroom.

Not only the competition itself but also what happens after the competition is important from educational point of view. The participants share their experiences with the solution of the competition problems and this also has serious educational effect. These after competition discussions might be as important as the preparation for and the competition itself. This is why the social program after the competitions should be considered as an extension of the competition and should be given proper attention.

There are many other ways in which the competitions influence, sometimes indirectly, the educational system and educational institutions. Practice shows that the presence of good students (competition participants) in class drives up the level of all the class by giving a "pattern to follow" and by motivating the other students to work harder. Moreover, the presence in class of such students places higher demands on the preparation of the teachers themselves. This two-way-prompt influences positively the entire educational process and improves, directly or indirectly, the reputation of the educational institution. The desire of many universities to attract good students by offering stipends and other privileges has a natural explanation. Enrolling competition winners has a long-term positive effect on the reputation of the institution. After graduation from the university, the competition participants, who already have problem solving skills, are likely to find solutions to difficult and complex real-life problems easier and faster than others. Once their success is noticed, the recognition of the university they come from increases almost automatically.

2. Thirty Years Since the International "Open Competition on Programming" in Bulgaria

To compete means to compare your abilities and skills with the abilities and skills of others. The broader the base of comparison (larger participation in the competition), the better. This is in the base of the frequently observed trend when school competitions outgrow the frames of the school and become town competitions, the latter grow again to national competitions and, finally, students get involved in international competitions. Informatics competitions appeared in some Bulgarian schools already in the late 70's of the last century under the name "Programming competitions". Originally, the solutions to problems given at the contests required mainly "paper work". The contestants were asked to write on a paper a program which, if run on a computer, performed a specific task. Then the papers were checked and assessed by the jury. If "computer time" was available, the programs of the students were executed on computer as well. The number of computers in the country in those years was very limited and the access to them for school students was rather restricted. With the advent of microcomputers the situation

changed. More and more school students got access to computers and this made it possible to organize competitions which are similar to the ones practiced today - the execution of the code on a computer became an obligatory part of the assessment. The national competitions in informatics exist in Bulgaria since 1981. The nation-wide Olympiad in Informatics (with this name) was started in May 1985.

The first international informatics competition in Bulgaria took place in Sofia on May 17–19, 1987. It was called "Open Competition on Programming" and was conducted just before (and in connection with) the Second International Conference and Exhibition "Children in the Information Age", May 19–23, 1987 (Sendov & Stanchev, 1988). Responsible for the organization of the competition were the Ministry of Culture, Science and Education, the Union of Bulgarian Mathematicians and the Institute of Mathematics at the Bulgarian Academy of Sciences. There were 28 contestants (school students) from 6 countries: Bulgaria (BG), Czechoslovakia (CZ), Federal Republic of Germany (FRG), Hungary (H), Romania (R) and Soviet Union (SU). Bulgaria and Romania participated with two teams. The students were divided in three age groups (less than 14, less than 16 and less than 18 years). The problems for all age groups were selected and prepared by the International Jury chaired by Petar S. Kenderov (with Zdravko Vassilev as Deputy) on the base of problems proposed by the team leaders of the participating countries. All problems were hard and related to real-life applications (Kenderov & Maneva, 1989). The competition lasted four hours. The results of the students were excellent. Some of them discovered original approaches to the complete solutions. Others had found the right way to the solution but did not have enough time to solve the problem completely. Even the students who were not quite successful in this competition had shown by their work that they completely deserve to be participants in an international competition on programming. The jury gave two first prizes - to Markus Gutschke (FRG) and to Vulcho Vulchev (BG1). There were three second prizes: Dimitrij Evsjuhin (SU), Andrei Dobos (CZ) and Tomas Mueller (FRG). Vladimir Vesely (CZ), Michael Sperber (FRG) and Svetoslav Nestorov (B2) got third prize. The competition was a success and sparked great interest and enthusiasm both among participants and organizers. Evgenia Sendova who is known for her great appreciation of everything related to informatics and school greeted the participants with the following inspiring words:

Welcome, welcome dear friends
representing many trends
coming to a competition
we hope it will become tradition.
Is it not a great idea
to gather all of you in here
to show that you are very clever
and you will become friends forever.
Higher, stronger, further wiser –
Friendship is the best adviser

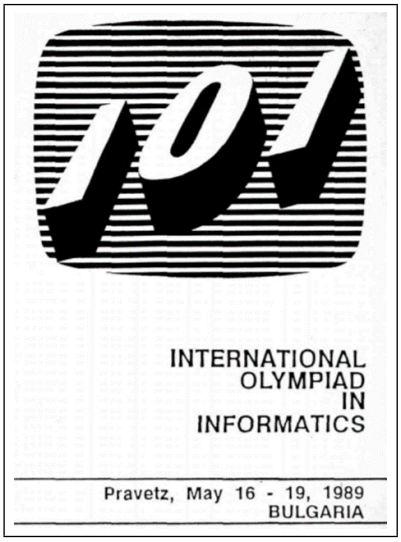
One of the byproducts of this competition was the idea that it is time to organize an international Olympiad in informatics. At the 24th session of the General Conference

of UNESCO held six months later in Paris, Professor Blagovest Sendov, a member of the Bulgarian delegation, suggested to include an International Olympiad in Informatics (IOI) in the Fifth Main Program of the UNESCO Plan for 1988-89. The proposal was approved and by a contract with the UNESCO Division of Science, Technical and Environmental Education, Bulgaria took on the obligation to organize the first IOI just before the third Conference and Exhibition "Children in the Information Age" (Sofia, May 20–23, 1989).

Additional experience in conducting international informatics competitions was gained in 1988 when a competition for school students from technical schools was held in Bulgaria (Varna, October 5–8). There were 19 students from six countries: Bulgaria, Cuba (C), German Democratic Republic, Hungary, Poland (P) and the Soviet Union. The International Jury was guided by Pavel Azalov (Chairman) and Evgeni Genchev (Deputy Chairman). There were two first prizes which went to Georghi Rivov (BG) and Marchin Wojas (P). A second prize was given to Alexiel Matos (C) while the third prize went to Pavlin Kostov (BG).

3. The first IOI – International Olympiad in Informatics

The first IOI was conducted in Pravetz, Bulgaria, from 16th to 19th of May, 1989. It was modeled after the International Mathematical Olympiad (IMO) and this was explicitly mentioned in the written Regulations of IOI. For instance, the participating countries were required to send to local organizers sample problems in advance from which the International Jury had to select the problems to be given at the competition. Only participants younger than 19 years old by the beginning of the competition were admitted.



The front page of the book of Kenderov & Manev (1989) with the logo of IOI.

In the first half hour after the start of the competition the participants had the right to put questions to the International Jury (in written form) concerning the formulation of the problems. The student work was preliminary checked and assessed by the respective team-leader and then finally marked by the "Coordinating Commission". The final marking was with the International Jury which decided also how many first, second and third prizes are to be given to most successful participants. All expenses related to the stay in Bulgaria of the teams and the team-leaders were covered by the organizers. There was an excursion to Sofia and an entertainment program for the participants in the competition. Professor Iltscho Dimitrov, the then Minister of Education, gave a reception for IOI participants.

There were however significant deviations from the established routine of IMO. According to the rules of IOI, a team consisted of not more than three students accompanied by a team-leader. With teams of six students which was the case in IMO, it would have been difficult for organizers to ensure support for local expenses of participants and to provide the necessary number of computers (APPLE II compatibles or IBM PC/ XT/AT/ compatibles) for all contestants. Another deviation from the practice of IMO was that, while doing the preliminary assessment of the papers, the team-leader had the right to talk to a participant and to ask for explanations of his/her work. This helped significantly the process of marking the papers. At the end of the competition each team leader accompanied by a member of the Coordinating Commission collected the problem solutions from the members of the respective team. The work of each student (the final version of the solution) was copied on two floppy disks. One of them remained with the team leader and the other stayed with the Coordinating Commission. The program of each student was run with a set of preliminary prepared (and approved by the Jury) Test Examples.

Thirteen countries have sent teams to IOI. These were (alphabetically): Bulgaria, Cuba, Czechoslovakia, Federal Republic of Germany, German Democratic Republic (GDR), Greece, Hungary (H), Peoples Republic of China (PRC), Poland, the Soviet Union (SU), Vietnam, Yugoslavia and Zimbabwe. The teams from Hungary and from Yugoslavia had two students each. Bulgaria participated with two teams and the Soviet Union with three teams. Thus, altogether, there were 46 students distributed in 16 teams. The International Jury consisting of Chairman (Petar S. Kenderov), Deputy Chairman (Nelly Maneva) and the team leaders gathered on Wednesday morning (May 17, 1989) to select a problem for the competition. A special Scientific Commission has prepared in advance six problems based on suggestions made by team-leaders before the IOI. By a procedure described in (Kenderov & Maneva, 1989) the International Jury selected a problem which was originally proposed by China. Then the problem was refined and formulated in the official languages of the Olympiad: English and Russian. The team-leaders translated the problem into the respective languages understandable to their students.

Here is the problem given at the first IOI (by default N stands for an arbitrary positive integer):

Given $2N$ *boxes in line, side by side; two adjacent boxes are empty, and the other boxes contain* $N-1$ *symbols* "A" *and* $N-1$ *symbols* "B".

Example for N = 5.

A	B	B	A			A	B	A	B

Exchanging rule:
The contents of any two adjacent non-empty boxes can be moved into the two empty ones, preserving their order.

Aim:
Obtain a configuration where all A*'s are placed to the left of all* B*'s, no matter where the empty boxes are.*

Problem:
Write a program that:

1. *Inputs from the keyboard the initial state as a sequence of* A*'s and* B*'s and zeros (for the empty boxes), and models the exchanging.*
2. *For a given initial state finds at least one exchanging plan, which riches the aim or reports that such a plan does not exist. The output should contain the initial state, the intermediate states after each step, and the final state.*
3. *Finds a plan reaching the aim with a minimal number of steps.*

Results:
Present at least one solution for the example mentioned above.

The maximal number of points given for a complete solution to this problem was 100. Those students who scored above 90 points were given the first prize. These were: Teodor Tonchev (BG2), Markus Kuhn (FRG), Emanuil Todorov (BG1), Andrius Cepaitis (SU1), Igor Maly (CZ) and Daniel Szabo (H). Second prize was given to students who got between 80 and 90 points. These were: A. Altanov (BG1), I. Marinov (BG1), H. Schwetlick (GDR), U. Nielaender (GDR) and L. Novick (SU1). The third prize went to students who got points in the range 60-80. Two encouragement prizes were also awarded. One of them went to Alexei Kolybin (SU3) who was the youngest participant and the second was given to Anita Laloo (Zimbabwe) – the only girl among the participants.

The first eight places in the unofficial country (team) ranking is given by the next Table 1:

Table 1

The first eight places in the unofficial country (team) ranking

No	Country/team	Team Leader	Score
1	Bulgaria (first team)	P. Azalov	275
2	Peoples Republic of China	W. Wu and Q. Ling (Deputy)	221
3	Federal Republic of Germany	P. Heyderhoff	215
4	Czechoslovakia	O. Demacek	209
5	German Democratic Republic	M. Fothe	207
6	Soviet Union	V. Kirjuchin	190
7	Bulgaria (second team)	K. Manev	188
8	Hungary (two students only!)	T. Toeroek and L. Zsako (Deputy)	149

Many people contributed to the organization and conduction of IOI. The work of the International Jury was supported by the software system created by P. Azalov and V. Dimitrov. In the hands of I. Nenova and V. Dimitrov this system served perfectly all the information needs of IOI – starting with the registration of participants and ending with the ranking with respect to results obtained in the competition. Alexander Pokrovsky from UNESCO (Division of Science, Technical and Environmental Education) was involved in all stages with the organization and conduction of IOI.

4. Additional Competitions Needed

As mentioned in (Kenderov, 2006) the traditional Olympiad-style competition along with the very positive features have some shortcomings when it comes to the identification of talent and inclination to research work. Most such competitions are limited in time to several hours and this imposes a significant stress on the nervous system of the participants. The students have to solve the problems correctly, quickly and in the presence of their direct competitors. Yet, there are many highly creative students, who do not perform well under pressure. Such "slow thinkers" often come up with new and valuable ideas a mere day (or even just five minutes) after the end of the competition, yet receive no reward or incentive. Traditional competitions disadvantage such students, even though some of them are highly creative and could become good inventors or scientists. Indeed, what matters in science is rarely the speed of solving difficult problems posed by other people. More often, what matters is the ability to formulate questions and pose problems, to generate, evaluate, and reject conjectures, to come up with new and nonstandard ideas. All these activities require ample thinking time, access to information resources in libraries or the Internet, communication with peers and experts working on similar problems, none of which are allowed in traditional competitions.

Obviously, other types of competitions are needed to identify, encourage, and develop such special "slower" minds. The competitions should reflect the true nature of research, containing a research-like phase, along with an opportunity to present results to peers – precisely as it is in real science.

As a matter of fact, such competitions, designed to identify students with an inclination to scientific research in the field of informatics already exist in many countries. It make sense to think about establishing an international competition of this type.

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P.S. Kenderov. One of the masterminds and major driving force behind the establishment of the first International Olympiad in Informatics (IOI) in 1989. Co-founder of the International Olympiad in Linguistics in 2003. Professor of Institute of Mathematics and Informatics of Bulgarian Academy of Science. Winner of the Erdös award in 2014 due to his significant role in the development of mathematical challenges worldwide.