

Bulgarian Olympiad in Informatics: Excellence over a Long Period of Time

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Abstract. Competitions in informatics for secondary school students in Bulgaria have long traditions. The National Olympiad in Informatics started in 1985. Bulgaria is the founder and the first host of the International Olympiad in Informatics (IOI) in 1989. Our participation in IOI has brought us 24 gold, 41 silver and 31 bronze medals, with which Bulgaria ranks 5-th place in the all-time overall standings by medals up to the last IOI 2016. The paper presents the current situation and challenges in the area of Informatics competitions in Bulgaria. The structure of the competition system, including the Bulgarian National Olympiad in Informatics is outlined.

Keywords: competition in informatics, informatics education, Olympiad in informatics, training.

1. Introduction

Starting from 80's

The programming contests for school students in Bulgaria started in early 80's of the past century (Manev et al., 2007). In the schedule of traditional Winter Mathematical Competitions, organized by the Union of the Bulgarian Mathematicians, a Programming tournament was included. The participants had to write a program in one of the languages FORTRAN or PL/1, that solve a given algorithmic task, to punch source on cards, compile it (computers was IBM/360 compatible machines) and to try to debug the program for 3–4 runs (no more runs were possible in limited to four hours contest).

In 1982 Bulgaria started to produce the Apple II-compatible machine Pravetz 8. Very soon many Bulgarian schools had at least one computer lab. So, each participant in Winter tournament had the possibility to work on an individual computer. The languages BASIC and Pascal replaced FORTRAN and PL/1. Evaluation of solutions in

those years was pure manual and some quantity of marks was assigned for the style of programming.

Four years expertise from Winter tournament was enough for the Team of the Union of the Bulgarian Mathematicians to be able to organize a National Olympiad in Informatics (NOI). In 1985 the First NOI took place. This was a two day contest. In the first day contestants had to solve some theoretical task – concerning the algorithmic knowledge and knowledge of the programming language. The second day was similar to the Winter tournament – the contestants had to write and debug a program. Starting from the Second NOI, in each of two days contestants had to solve one task by writing a corresponding program. There was no special qualification for participating in the Final round of the first few NOI. Many schools organized its own contests to decide which students would be sent to the Final.

The NOI started with one age group in 1985. Now the contestants are divided in 5 age groups – E (4th–5th grade), D (6th–7th grade), C (8th grade), B (9th–10th grade) and A (master group). Contests in different groups have different duration – 3 hours for E, 4 hours for D and C, and 5 hours for B and A. Contests are purely conforming to the format of IOI. Does not matter in which group participates, each contestant has an own workplace and must solve three task of algorithmic type, writing the corresponding programs in the official language of IOI: C++.

Today's Structure of National Olympiad in Informatics (NOI)

For more than 30 years the NOI of Bulgaria totally changed. Nowadays we have 3 rounds – Local/School (in February), Regional (in March) and Final/National (in April). The teachers of schools are free to prepare their own tasks for the Local round. For helping schools (especially in small villages) that are not able to prepare tasks, the National Committee (NC) proposes a set of sample tasks for this round. The round is not a formal qualification. The teachers, that evaluate the contestants, decide who is ready to participate in the Regional round.

Tasks for Regional and Final round are prepared by the NC. Regional round is organized in schools in one day with common start. Solutions of the pupils are sent immediately to the work groups of NC that evaluate and grade them with common set of test data. The round is a qualification for the Finals of the NOI, Where 120 students from all age groups participate.

The Final round is organized in a different town each year. There are two contests (in two consecutive days). The first 12 students from the Final round in group A form the long list of the Senior National Team for Balkan Olympiad in Informatics (BOI) and IOI, and similarly the first 12 students from the Final round in group C (aged less than 15.5 years) form the long list of the Junior National Team for Junior Balkan Olympiad in Informatics (jBOI).

National Tournaments

In parallel with the NOI, 3 National Tournaments (NT) are organized by the Union of the Bulgarian Mathematicians and with the support of the Ministry of Education. The season starts with the Fall tournament in November. The traditional Winter tournament is in January or February and the final for the season is the Spring tournament in the beginning of June. The NTs are open, but to the level of certain quotas. Format of the contests in the NTs is the same as those of the NOI. But, in principle, tasks are more difficult, and frequently, during these contests, some experiments are made. Some new topics or types of tasks usually first appear in the NTs before to be given in the NOI.

2. Preparation and Selection of Students for the International Competitions

Control Contests for Qualifications

After forming of the two extended national teams (for junior and senior age) as a result of the National round of the National Olympiad, to continue with the selection of the teams that will represent Bulgaria in the international competitions, we conduct several control competitions. The number of these competitions and their dates depend on the registration deadlines of the corresponding International Competitions.

The senior team has presented our country on the following competitions:

- International Olympiad of Informatics.
- Balkan Olympiad in Informatics.
- Central European Olympiad.
- Romanian Masters of Informatics.
- International Tournament in Shumen.

The junior team has presented our country on the following competitions:

- Junior Balkan Olympiad in Informatics.
- International Tournament in Shumen.

Moreover, the junior team is preparing to participate for the first time this year on:

- European Junior Olympiad in Informatics.

Training

In about ten major cities in Bulgaria there are developed networks of out-of-school training through various forms of group organization. These groups are closely connected with mathematical high schools, where students are taught and are led by teachers, university lecturers and people from companies. It is very important to note the role of students' own motivation and self-preparation, which has become particularly possible in

the last years due to the contribution of the Internet to giving access to numerous foreign websites, related to competitions in informatics, including many online competitions.

The full publicity of all materials related to Bulgarian competitions in informatics is a great encouragement. The Competitive Informatics Committee of the Union of the Bulgarian Mathematicians maintains the “Infos” website with the full information on all national and international competitions (Infos, 2017).

We conduct two summer training camps to prepare students from the extended national teams for juniors and seniors, and one national academy where all competitors ranked in the top 10 places in the overall rankings for each school grade are invited.

Achievements of the Bulgarian Competitors at the IOI

Traditionally and for the entire period of time of IOI, the Bulgarian team shows a stable performance with a large number of medals. Fig. 1 illustrates the distribution of the medals of the Bulgarian participants from the First IOI up IOI 2016. Individual achievements with ranges of competitors are shown in Fig. 2, where our best performance so far is the second place for in the “all time” standings. The statistic source is (International..., 2017).

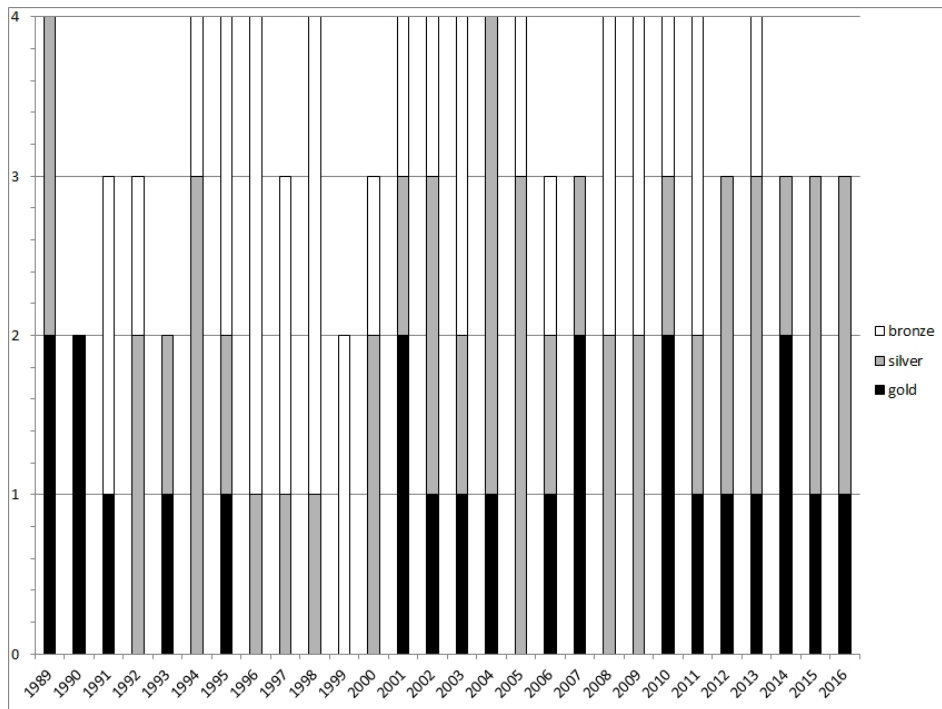


Fig. 1. Bulgarian participants medal achievement at IOI.

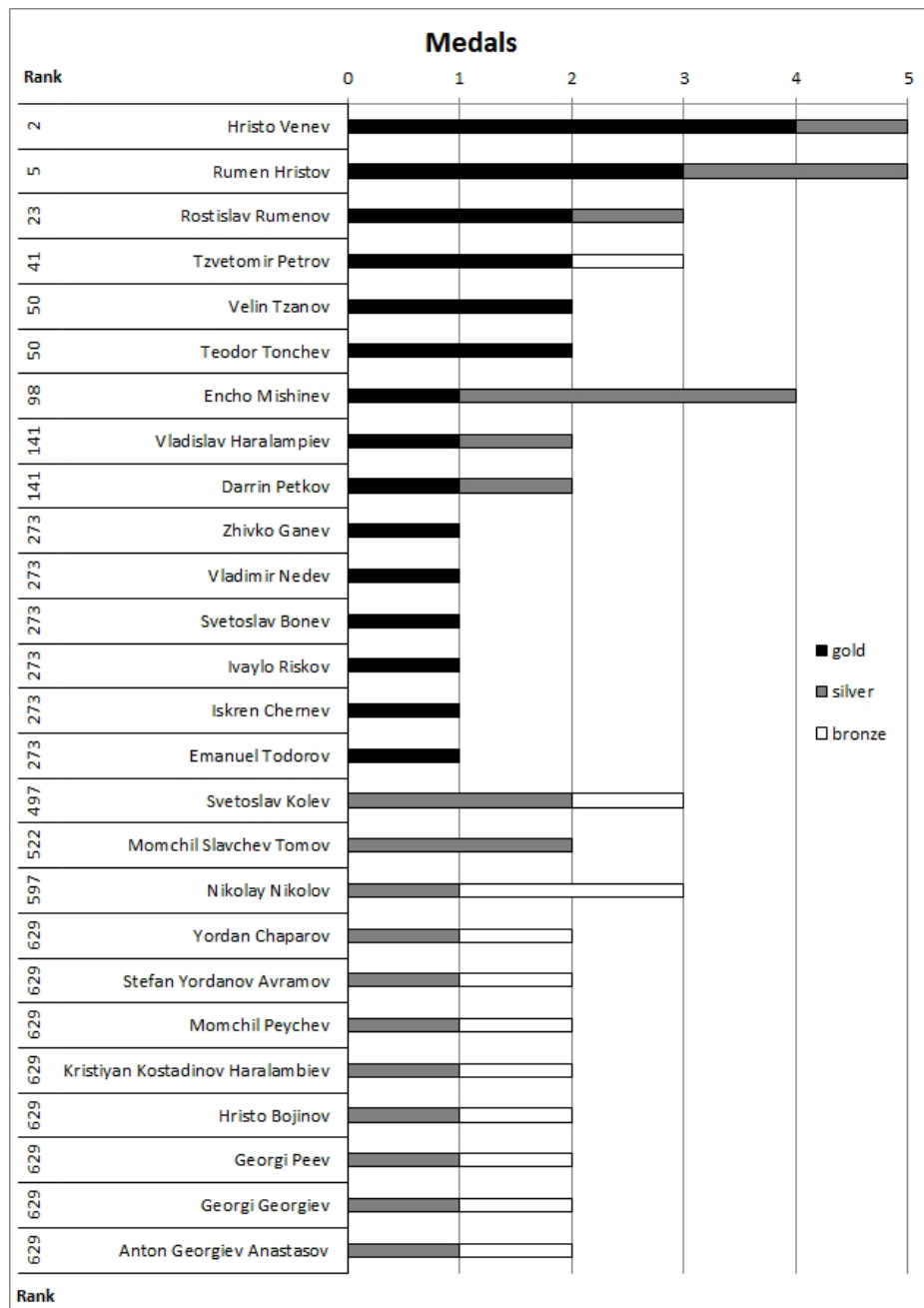


Fig. 2. Bulgarian achievements in the individual ranking for all IOIs up to IOI 2016.

Educational Content

Regarding the curriculum, which we use in preparing and defining the tasks given to the national competitions, it is aligned with the IOI contest materials. Fundamentals is our contribution in defining the material for beginners training starting at 11–12 age children, because this material does not exist at IOI.

Group E (4–5th Grade, 11–12 Year Old)

1. C++ Programming Environment. Simple data types. Input and Output.
2. Control structures and operations in the C++ . Conditional statements.
3. Cycles. Embedded cycles. Functions in C++. Strings.
4. Tasks related to dates and time.
5. Concept of a one-dimensional array.

Group D (6–7th Grade, 13–14 Year Old)

1. One-dimensional arrays and basic tasks with them. Introduction to Sorting Algorithms. Tools for strings and searching.
2. Divisibility of integers. Euclid's algorithm and its applications. Prime numbers. Sieve of Eratosthenes. Numeral systems.
3. Implementation for long integers. Random numbers.
4. Two-dimensional arrays and table processing. Structures in C. Arrays of structures.
5. Initial knowledge in computer geometry. Rectangles with sides, parallel to the coordinate axes. Square meshes, labyrinths and domains.
6. Standard library (including introduction to STL) and STL sorting tools.
7. Data structure: stack and queue.
8. Concept of recursion. Backtracking.
9. Fast algorithms for searching.
10. Introduction to Dynamic Programming.

Group C (8th Grade, 15 Year Old)

1. Extended Euclid's algorithm and applications.
2. Games with strategies, concerning parity and symmetry. Combinatorial games. Nim. Board games.
3. Bitwise operations and applications.
4. Dynamic programming: one-dimensional and two-dimensional tasks. Longest common subsequence. Shortest super-sequence.
5. Graphs: presentation and traversal (DFS, BFS). Directed graphs. Shortest path in graphs. Binary trees and trees for search. Pyramid data structure.
6. Algorithmic geometry: oriented triplet of points and applications.
7. Combinatorial configurations and counting.
8. Arithmetic expressions: representation, computation and transformation.

Group B (9–10th Grade, 16–17 Year Old)

1. STL Library: Containers and iterators, basic algorithms. Hashing.

2. Permutations: basic properties. Combinatorial configurations: encoding and decoding. Numbers of Catalan. Structures for representation of sets. Gray's codes. Decomposing of sets and numbers.
3. Algorithmic geometry: mutual position of points and straight lines. Polygons. Convex hull. Closest and most distant points. Diagrams of Voronoy.
4. Graphs: Bi-connectivity, strong connectivity, Euler tours and Hamilton cycles, Minimum spanning trees, matching in graph, critical path method, Maximum flow. Coloring. Planar graphs. Geometric graphs. Complex tree structures: Fenwick tree, segment trees.
5. Dynamic Programming: Profiles. Recurrent relations and recursion. Conversation of recursive programs.
6. Strings: search by pattern, distances. Effective structures and algorithms for strings. Data Compression: Huffman Codes. Formal grammars and automata.
7. Games: minimal strategies, alpha-beta pruning. Reactive games.
8. Systems of linear equations and integer solutions.

Group A (Master Group, 11–12th Grade, 18–19 Year Old)

1. All materials from the previous groups combined in complex tasks of the level of the IOI.

3. Conclusion

The institutions that organize and support the overall running of the Bulgarian national competitions and our participation in the international events are:

- Ministry of Education.
- Union of Bulgarian Mathematicians.
- Institute of Mathematics and Informatics at Bulgarian Academy of Science.
- National Sciences Olympic Team Association.

Alumni Involvement

With the increasing number of competitors from year to year, stronger and more solid alumni were built, especially since the establishment of National Sciences Olympic Team Association. Since most of them are still active participating in many programming competitions at the university level, they are up to date and exposed to the various new problems and materials that are suitable for training. Some of the alumni have worked and contributed at some prestigious IT related companies and some others have successfully established their own startups which are recognized both nationally and internationally.

Although we are supported by alumni, we are facing to a problem of shortage of young people, which are to be team leaders, coaches and task writers. Another problem that is appropriate to mention is the insufficient public attitude for recognition of the status of contestants and coaches in competitive informatics.

Research on the Work of the Participants

After having accumulated enough tasks previously given in competitions, it becomes possible to start an attempt for classification and introducing measure of difficulty as is considered in (Kelevedjiev, Dzhenkova, 2008, 2009, 2012)]. The authors of tasks for the Bulgarian competitions could find useful information about the history of tasks from the previous competitions in order not to duplicate or sometimes intentionally repeat some kinds of problems. In more broad sense, the study of the keywords might be applied for initializing appropriate changes and improvements in the national curriculum which is used now as a recommendable list of themes in all the set of local out-of-class forms for young student preparation in Bulgaria.

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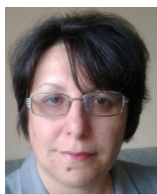
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