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REPORTS

Cyprus Olympiad in Informatics

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Abstract. This report presents the organization of the Cyprus Olympiad in Informatics in terms of the format used for each age group and the methods and tools utilized for the preparation and selection of the delegations of Cyprus for international competitions.

Keywords: Cyprus, International Olympiad in Informatics, Balkan Olympiad in Informatics, computer science, computer programming, curriculum, gymnasium, lyceum.

1. Introduction – Educational System in Cyprus

Education in Cyprus starts at the age of six and is divided into elementary and secondary education. Secondary education is divided into two levels – Gymnasium (ages 12–15) and Lyceum (ages 15–18). The Ministry of Education and Culture (MOEC), introduced Computers Science in Lyceums in the early 1990s. Computer Science was mandatory only in the first grade of the Lyceum, for two class periods per week. Students could choose to take the course in the second and third grade. LOGO and QBASIC were the programming languages used in the initial course.

A significant change was made in the early 2000s. Computer Science was made mandatory for all three grades of the Gymnasium. It was also introduced as an elective

course for the second and third grade of the Lyceum. Flow charts, Visual Basic and Pascal were the tools used to improve the algorithmic way of thinking of students.

Since then a lot has changed. In recent years, the CS curriculum in the public schools of Cyprus has undergone significant modifications in order to incorporate programming in each grade. Still, no CS curriculum exists for our elementary schools.

Currently, the tools and programming languages that are used for teaching programming in public schools are:

- Scratch (1st grade of Gymnasium).
- Alice, Robomind (2nd grade of Gymnasium).
- Pascal (3rd grade of Gymnasium).
- Pascal (1st grade of Lyceum).
- GameMaker (2nd grade of Lyceum).
- C++ (2nd–3rd grade of Lyceum).

The infrastructure in our Gymnasiums and Lyceums is relatively efficient. Every school has three to four computer labs, each one equipped with up to twenty computers. Every student works on his/her own computer during classes. A Computer Science teacher is responsible for the labs' maintenance and annual inspections are made to secure the longevity of the computers.

2. Cyprus Olympiad in Informatics (COI)

Cyprus participated for the first time in both IOI (International Olympiad in Informatics) and BOI (Balkan Olympiad of Informatics), in 1993. Cyprus Olympiad in Informatics (COI) was established in 2006 and it is organized annually by the Cyprus Computer Society (CCS) and the Ministry of Education and Culture (MOEC), in the following format. There are five academies, one in each district, that are responsible for preparing students for international competitions. The academies cover geographically most of Cyprus. In each academy, students are taught evening programming lessons, for two hours per week. Responsible for each academy is a Computer Science teacher assigned by the Ministry of Education. The top students are chosen to represent our country as members of the Cypriot delegations.

Up to 2011, the selection of the teams was made after two rounds of competition. The first round was on paper and the second one, although it was conducted with the use of computers, it was without the use of an online judge system and the solutions were judged manually. The main programming language the students used was Pascal.

In 2011 there was a major effort to improve things. C++ was introduced in the academies, as the main programming language and the curriculum harmonized with the one that is used in the IOI. Contest Management System (CMS) was used for handling the contests rounds. Another major change during that year was the introduction of the Bebras competition for younger students (12 to 15 years old). The Bebras contest runs in two rounds. The first is open for all Gymnasium students and the second is for the top students of each grade, which are also invited for the COI camps and lectures. In

Table 1
Cyprus medals in international competitions

IOI	BOI	JBOI	EJOI
• Silver (2017) • Bronze (1993, 2015, 2016)	• Silver (1993, 2016) • Bronze (1995, 1997, 2001, 2006, 2013, 2014, 2015, 2016, 2017)	• Silver (2017) • Bronze (2015 – 2 medals, 2016, 2017, 2018)	• Silver (2017) • Bronze (2017, 2018)

the past, most students participated in the COI competition after the age of 15. With the Bebras competition, younger students were attracted. The youngest contestant who competed in 2018 was 12 years old.

The results of the Cypriot delegations have improved drastically in recent years. Cyprus participated, for the first time, in the Junior Balkan Olympiad in Informatics in 2015 and won two bronze medals. Also, in 2015, Cyprus won its second medal in IOI after a long span of 22 years. As you can see from the statistics (Table 1), the changes have been effective:

2.1. *COI Format*

- Preliminary Round: Just before Christmas, four preliminary problems are announced publicly on CMS and students are given two weeks to submit their solutions. Their scores do not count for the first round.
- First Round (4 problems – 3 hours): Students that score at least 50% of the points of the first round qualify to the second round.
- Second Round (4 problems – 4 hours): The top 16~20 students qualify to the International Selection Rounds.
- BOI Selection Round (4 problems – 5 hours): Selection of the BOI team. Only students who have qualified from the second round can participate.
- IOI Selection Round (4 problems – 5 hours): Selection of the IOI team. Only students who have qualified from the second round can participate.
- JBOI/EJOI Round (4 problems – 4 hours): Selection of the JBOI/EJOI team. Only the students who participated in the second round and are eligible from JBOI age standards can participate.

Responsible for organizing COI is the Cyprus Computer Society (CCS) in co-operation with the Ministry of Education and Culture (MOEC). CCS is a professional and independent non-profit organization, seeking to improve and promote high standards amongst informatics professionals, in recognition of the impact that informatics has on employment, business, society as well as on the quality of life of the citizen. The MOEC is responsible for promoting Computer Science for all students in a unified educational system. The Ministry acts as the supervisor for COI in terms of personnel selection, support and setting a common policy for all districts involved.

3. Preparation for COI and International Contests (IOI, BOI, JBOI/EJOI)

3.1. *COI Syllabus*

The COI curriculum is divided into 3 parts, depending on which round the students are competing:

1) First Round:
   - Basic Programming.
   - Strings.
   - Arrays (1d, 2d).
   - Searching/Sorting.
   - Stacks/Vectors.
2) Second Round and JBOI Selection:
   - Functions/Recursion.
   - STL (maps, sets, queues, pairs).
   - Graph Theory:
     - Graph Traversal (DFS/BFS).
     - Shortest Paths (Dijkstra, Floyd-Warshall).
     - Minimum Spanning Trees (Prim, Kruskal).
   - Complete Search.
   - Greedy Algorithms.
   - Introduction to Dynamic Programming.
3) Curriculum for IOI and BOI Selection Rounds:
   - Advanced Dynamic Programming.
   - Bitmasks.
   - Advanced Graph Theory:
     - Trees.
     - Directed Acyclic Graphs.
     - Successor Graphs
   - Range Queries:
     - Segment Trees.
     - Binary Indexed Trees.
     - Sparse Tables.
   - Computational Geometry.
   - String Searching Algorithms:
     - Knuth-Morris-Pratt Algorithm.
     - Rabin-Karp Algorithm.
     - Tries.
     - Hashing.
     - Suffix Arrays.
   - Number Theory.

For developing the COI curriculum, an extensive literature review on competitive programming books was used as well as an in-depth investigation of other countries' preparatory systems.

3.2. *Training Camps*

In 2012, training camps were introduced. The focus was to teach the contestants advanced topics and give them an opportunity to meet each other and to build a learning community. The first years, the camps were two days long during Easter Holidays, just before the international selection rounds. The lessons were taught by guest lecturers from Greece. During the span of two days, the camps covered a lot of material, but because of the limited time, the content was not understood completely, by all students. Additionally, it was the only on-site advanced training our experienced contestants had during the year.

In 2018, winter camps were introduced and the format of the camps changed. There are two advanced topics lectures per day and a 2-hour contest at the end of each day, giving the opportunity to get hands-on the new knowledge acquired. Currently, there are two difficulty levels: junior and senior. The junior level was introduced to recruit new contestants to the competition and the senior level is for international contest preparation. The topics are different each time giving the opportunity for all contestants to learn something new in each camp they are attending.

In the future, there are plans to organize summer camps in order to train the national delegations, just before the international competitions. Moreover, lectures are planned during the summer for Gymnasium students in order to prepare them for JBOI 2020, which will be hosted in Cyprus and to better prepare our future IOI contestants.

3.3. *Tools and Resources Used*

These are the tools that are used within the lectures in order to prepare students for competing. These tools are used during the training camps as well:

3.3.1. *Contest Management System (CMS)*

We currently use CMS 1.4 as our contest environment for all the rounds of the competition. The setup is one machine that runs all the services and handles the submissions (log service, contest web server, admin web server, etc.). For BOI 2016, which was held in Cyprus, we used the CMS 1.3 and the setup was across three machines. The first machine was running only the services and the other two were handling the submissions, with four workers on each machine. No technical problems or delays in submissions were detected.

3.3.2 *Michanicos Online Judge*

Michanicos is a localized online judge build upon CMS and CMSocial, which currently holds approximately 200 problems in the Greek language and it is publicly available to our students. The platform allows for the district instructors to upload programming tasks and lecture notes through the administrator panel, set up different task tags and categorize their material. It allows for multiple contests to be run simultaneously, completely separated from the CMS platform used for our official competition rounds. The platform allows submissions in C, C++, Pascal, Java and Python, offers complete control over the students' submissions and generates reports and statistics for all contestants. Michanicos serves also as a repository for all the tasks used in our previous contests. It has been a very significant upgrade to our training process.

3.3.3. *Additional Resources*

Since the language barrier is not an issue as most of our students speak English fluently, the use of the following resources is highly encouraged.

Tools used for problem-solving training:

- Online Judges:
  - SPOJ.
  - Codeforces.
  - USACO.
  - CodeChef.

3.4. *Statistics*

The Table 2 shows the student participation in COI contests for the past five years.

4. Conclusion

Cyprus is a small island, with a population of 800,000 people. It is understandable that our selection pool is very small each year. Many of our students participate in other Olympiads as well (e.g. IMO, IChO). Some additional problems that COI is facing, is

Table 2
Student participation in COI and Bebras

Contest	2015	2016	2017	2018	2019
Bebras Contest	457	638	825	721	689
First Round	102	112	123	142	158
Second Round	43	52	67	62	44
Third/Fourth Round	12	15	16	20	21
JBOI Selection	17	16	24	14	13

the lack of academic support and the lack of training for our instructors. The COI alumni are very important too, but, unfortunately, most of them are studying abroad. In 2016, Cyprus organized the Balkan Olympiad in Informatics with great success, which we hope to repeat for JBOI 2020. Despite the problems, Cyprus puts a lot of effort and resources to help its students and put them in a position to be successful. We have gone from zero total points to a silver medal within the past eight years and we hope to win Cyprus' first gold medal in the near future.

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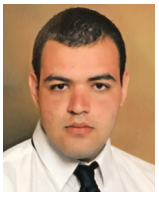
P. Eracleous works for the Ministry of Education and Culture in secondary education, since 2003. He holds an MSc in Computer Science from Middlesex University and a BSc (Hons) in Computer Science from Purdue University. He has been involved in curriculum development for secondary education and has co-authored the books used in Lyceum Computer Science courses. Since 2011, he is the Cyprus Olympiad in Informatics instructor for the district of Nicosia and he is responsible for the selection and preparation of the delegations of Cyprus for international competitions. He has been the team leader of Cyprus in IOI from 2015 to 2019. He was a member of the Scientific Committee for the Balkan Olympiad of Informatics hosted in Cyprus in 2016.

P. Pavlikas graduated from the Department of Electrical and Computer Engineering of the Aristotle University of Thessaloniki. He also holds an MSc in Information Systems from the Open University of Cyprus. He works for the Ministry of Education and Culture in secondary education since 2003. He worked as a Computer Science Advisor for the Ministry of Education for 5 years and he co-authored the curriculum and books used for secondary education. From 2009 until 2018 he was the COI instructor for the district of Larnaca. He has been the team leader for Cyprus in several international competitions.

A. Ttofari is a student in the Department of Computer Science at the University of Cyprus. He participated in IOI 2014 and IOI 2015 and he was a deputy leader of many Cypriot Delegations since 2016. He started as a teaching assistant in the district of Larnaca in 2015 and currently he is teaching in the Nicosia district, since 2016. Additionally, he serves as a problem setter and organizer for the training camps for COI.



A. Charalambous is a student in the Department of Computer Science at the University of Cyprus. He started as a teaching assistant for the district of Nicosia in 2016. He is in the technical committee of COI and he is responsible for the maintenance of the server machines and the administration of the Contest Management System.