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Italian Olympiad in Informatics: 10 Years of the Selection and Education Process

Mario ITALIANI

Dipartimento di Scienze dell'Informazione Università di Milano
Via Comelico 31, 20131 Milano, Italy
e-mail: mitaliani@alice.it

Abstract. This article describes the selection and training process of the Italian Committee for the International Olympiad in Informatics to identify and prepare the Italian team members participating in the international olympiad. Special attention is dedicated to the first step in the selection process, which involves schools from all over the country. Examples of problems submitted to the contestants in this first selection phase are also provided.

Key words: olympiads, programming contest, selection, training.

1. Introduction

In the year 2000 Italy started to participate in the International Olympiad in Informatics, following an agreement between the Italian Ministry of Education, University and Research (MIUR) and AICA, the most important association of Italian computer scientists, which represents teachers and researchers of Italian Secondary Schools and Universities, as well as professionals working at institutions or companies using or providing information and communication technology.

The agreement led to the establishment of a "National Olympic Committee", made up of members appointed by MIUR and AICA on a joint basis. The costs for the preparation and participation of Italian contestants in the olympiad are borne by MIUR and AICA on an equal basis.

The Committee relies on a group of researchers and teachers, the so-called "national trainers", who take care of a complex training and selection process which lasts two years, due to the fact that Italian secondary schools do not give the necessary importance to computer science. It is therefore necessary that students showing special talent in the preliminary selection phases are provided with a solid preparation in programming, particularly in the algorithmic area.

2. The Selection and Training Process

2.1. *The First Step: The School-Based Selection*

The first step in the selection and training process for the annual international competition is the "school-based selection", which is carried two years before the international olympiad, in the months of November/December, at the schools which have applied. The school selelection usually involves 500 schools for a total number of approximately ten thousand students.

The school selection takes place on the same day at all participating schools, which receive the text of the competition by telematic means shortly before the begin of the test. School personnel subsequently collects and marks the answers given by the students in ninety minutes, and then transmits (again by telematic means) the ranking to the Olympic Committee.

During the test, the students are required to answer 20 questions (mainly math and logic questions or algorithmic ones) and are allowed to use only paper and pencil.

Math and logic questions aim to assess the students' capacity to rapidly make logical connections and use simple mathematical instruments, while the objective of algorithmic questions is to evaluate the student's capacity to perform a simple succession of operations to solve elementary problems.

These two sets of tasks are supplemented by further questions to determine whether the student possesses programming fundamentals. These last questions are not particularly challenging and take into account the inadequate preparation of Italian schools in programming, as talented students should not be prevented from participating to subsequent phases in the selection and training process, which could give them the opportunity to fill their gaps in programming.

Some examples of the questions submitted in the latest school selection are provided in the Appendix.

2.2. *The Second Step: The Territorial Selection*

Based on the ranking provided by each school at the end of the first selection phase and on some rules aiming to guarantee, where possible, the presence of at least one student from each school, the Olympic Committee drafts a national ranking and selects approximately one thousand students that are admitted to the second step in the preparation and selection process, which is the so-called territorial selection, which takes place at various schools all over the country (at least one for each Region), chosen according to the availability of appropriate IT equipment and of competent personnel.

The territorial selection is carried out in the month of April of the year preceding the international competition.

The test requires participants to design algorithms and realize the related programs for the solution of problems whose complexity is not high and anyway substantially lower than that of problems submitted in the international olympiad.

The programs realized by participating students by using Pascal or C/C++ language in Linux or Windows environment are submitted to a centralized server that automatically compiles them and submits them to test data. Territorial rankings are therefore drafted, as well as a national one to identify about eighty students who are admitted to the following selection phase.

In the period between the school-based and the territorial selection, participating schools are invited to organize training activities for students who have succeeded in the first selection phase, by involving in-house and external teachers, and relying on the teaching material available on a site managed by the Olympic Committee.

2.3. *The Third Step: The National Selection*

The national selection aims to identify a group of 15–20 students who are considered as the "probable olympiad participants", among which the members of the olympiad team are finally chosen. The olympiad team is made up of 4 regular members and 2 substitutes, who will participate in the international olympiad.

The national selection takes place on one single day in the month of November of the year before the international olympiad, in a venue chosen by the Olympic Committee, every year in a different region. The problems submitted to the participating students are similar to those of the international contest, although the level of complexity is lower, because in the period between the national selection and the international olympiad the preparation of probable olympiad participants (or a part of them) is expected to be improved thanks to the specific training activities planned.

The regional MIUR offices organize training activities for students participating in the national selection, often by relying on University professors and researchers of IT Departments in the various regions.

An IT tool has recently been developed to make individual training activities more effective. This tool is interesting for both students preparing for the national selection and those training for the territorial selection. This tool operates as an on-line teacher that provides students with a set of problems of different levels of complexity and origin and allows them to choose a specific problem and to submit the solution in a file containing the text of the source programme. The "on-line teacher" compiles the program, identifies any errors, and, if possible, executes it on a certain number of predefined test cases, and finally informs the user of the outcome.

2.4. *The Italian Olympiad*

For some years now the national selection has been considered as an Italian Olympiad, in order to make the participation to the selection more appealing to students and, especially, their teachers.

The best students are awarded with gold, silver and bronze medals, following criteria in line with those adopted for the international olympiad.

The prize-giving ceremony takes place on the day after the contest and consists in a party with the participation of contestants, their teachers and the Olympic Committee,

as well as school and public officials/authorities of the Italian region hosting the competition. A small ceremony is also organized in which the school hosting the competition passes its role to the school which will host the competition in the following year.

The initiative has been appreciated, as it has become an opportunity for teachers to meet, while contestants are different every year.

2.5. *The Fourth Step: Training the Olympiad Team*

In the months before the international competition, the probable members of the olympiad team selected through the national competition, who make up a team of 15 to 20 students (5 gold medals, 10 silver medals and some particularly promising bronze medals) participate in a training provided both in form of residential seminars managed by national trainers (lasting 3–4 days each) and of Internet-based training. The latter is provided in order to reduce the interference of olympiad training on regular school activities.

It can happen that some of the selected students leave the training after some time because they realize they do not measure up to their colleagues, while some others are advised to withdraw from the training before its completion. At the end of the last residential seminar, the olympiad team, made up of four regular members (as well as two substitutes), is chosen and will be followed by the trainers through remote systems until the departure to the city hosting the international olympiad.

The selection of the four regular team members is mainly based on the results obtained by the contestants in a series of tests simulating the conditions of international olympiad competitions.

3. Conclusion

In the first years of its participation to the international olympiad, the Italian team obtained only some bronze medals, but throughout the years results have improved and become more satisfying partly due to the effective selection process and training activities, but especially thanks to the contestants' commitment. The Italian team has achieved a gold medal (unfortunately only one so far), eleven silver medals and seventeen bronze ones.

These results, which hopefully will constantly improve in the following years even if the international competition is very tough, show that young Italian students have a good level of talent and skills, despite the insufficient attention given by school institutions to teaching of Information Science's foundations.

A negative aspect noted in the Italian participation in the competition, which the Olympic Committee has not succeeded in remedying, is the low percentage of women in the selection phases and the mediocre results obtained by the few girls who have passed the school-based selection.

The Committee has long been analyzing this problem and intends to define a strategy to improve the female students' commitment to participate in olympiads and drive them to the achievement of the success results that can surely be obtained.

4. Appendix

Some of the questions submitted to the students in the latest school-based selection are reported below. Examples of the problems presented in territorial and national selections are not reported, as they are similar, although less complex, to those submitted in the international olympiad.

a) Math and logic question (weight = 1 point)

If you throw two dice, what is the probability of obtaining 6 (obviously by adding the values of the two dice)?

Possible answers:

a) 18/36
b) 12/36
c) 5/36
d) 7/36

b) Math and logic question (weight = 3 points)

Consider the following multiplication:

$$\begin{array}{lcccc} A & * & * & * & \times \\ B & & & * & = \\ \hline C & * & * & * & * \end{array}$$

where each of the figures of the three numbers A, B and C (indicated by the symbol *) can be only 3, or 5, or 7. What are the three numbers A, B and C?

c) Algorithmic question (weight = 1 point)

In order to respect the timetable of reservations for the delivery of pizzas at the odd-numbered houses of the same street, pizzas should be delivered by following the instructions based on a code specifying how to go forwards (e.g., F2 to move forward of two buildings) and backwards (e.g., B5, to move backwards of five buildings) along the street starting from a specific point.

An example for the delivery of 4 pizzas: if starting from house no. 1, the instructions were [F2, F1, B2] the delivery would be in this order [1,5,7,3] which indicate the number of the odd-numbered houses where pizzas should be delivered.

Seven pizzas should be delivered. The first one should be delivered at house no. 1, while the remaining ones should be delivered by following these instructions: [F3,F4,B5,F6,B3,B4]. Find the list L containing the right order of the house numbers where pizzas will be delivered.

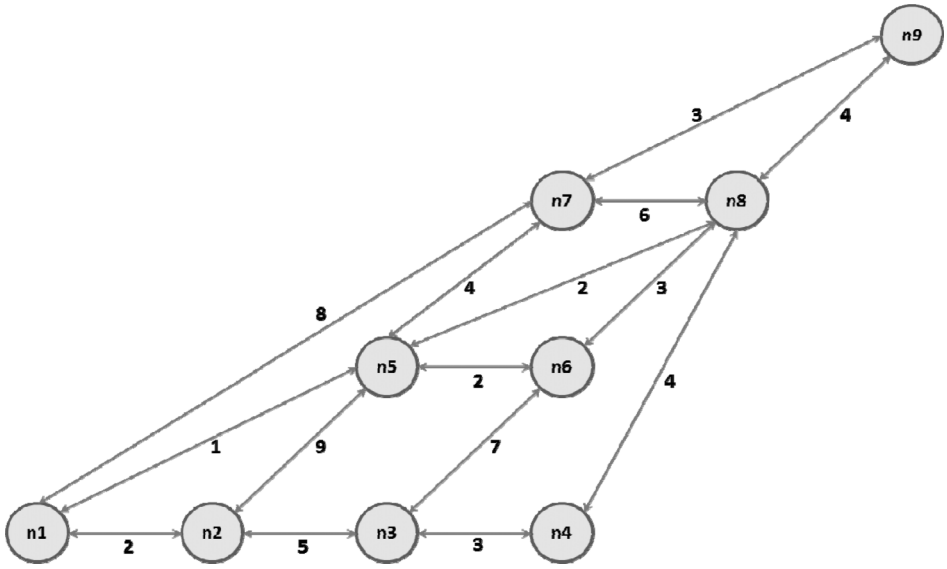

Fig. 1. A street map.

d) Algorithmic question (weight = 3 points)

The term a(<node1>,<node2>,<distance>) describes the street connection between node1 and node2, and provides the relating distance in kilometres.

Consider the street map composed by the following connections:

a(n1,n2,2) a(n2,n3,5) a(n3,n4,3) a(n4,n8,4) a(n5,n6,2) a(n6,n8,3)
a(n1,n7,8) a(n8,n7,6) a(n5,n1,1) a(n2,n5,9) a(n3,n6,7) a(n5,n7,4)
a(n9,n7,3) a(n8,n9,4) a(n5,n8,2)

as shown in the Fig. 1.

The distance between two nodes is described by the list of nodes, which are ordered from the departure node to the arrival node. The total distance in kilometres of each connection can obviously be calculated.

For example, the connection: $L =$ [n1,n7,n8,n6] has a distance K of 17 Km.

Find the number N of different connections departing from the node n2, ending in the node $n9$ and crossing once all the nodes in the picture. Among these connections, provide the list $L1$ of the shortest distance and the list $L2$ of the longest one.

e) Programming question (weight = 1 point)

Consider the following fragment of a program:

```
int r, c, s;
printf("Input a full number between −10 000 and 10 000:");
scanf("%d",&r);
c = 1;
```

```
c = r * c;
s = 1;
if (c <= r) {
  s = s + c;
  c = c * 2;
  }
printf("the variable s is %d\n",s);
```

Which of the following statements is true?

a) *The sum of all numbers from 1 to* $r+1$ *is shown.*
b) *The value* $r+1$ *is shown.*
c) *The value* $r+1$ *is shown only if* $r >= 1$.
d) *The value* $2r+1$ *is shown.*

f) Programming question (Weight =3 points)

Consider the following fragment of a program:

```
int succ(int i) {
  if (i <= 2)
    return(1);
  else
    return(3*succ(i-1)+2*succ(i-2)-succ(i-3));
}
main() {
  printf("num=%d\n",succ(7));
}
```

What appears on the screen if `main()` is executed?

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M. Italiani started its activity in 1959 in the Research & Development Team of Olivetti's Electronic Division in Milan. He has been full professor of computer science subjects at the Universities of Turin, Pavia and Milan since 1976. He has been the president of AICA, the association that, in co-operation with the Italian Ministry of Education, University and Research, promotes the Italian participation in the International Olympiad in Informatics. He is currently member of the Italian Olympic Committee.