# COMPETITIVE PROGRAMMING.
# AN ANALYSIS OF THE PERFORMANCE IN ROMANIA

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**Abstract:** *Competitive programming is that branch of programming that challenges the programmer to exceed his own limits, to push his creativity to a new level. It is a mind sport, where the programmers are challenged not only to solve algorithmic problems, but to deliver the most performant solution, that will fulfill the very strict specifications of the problems. This requires the programmer to have a very good knowledge of algorithms, data-structures, a strong mathematical foundation, and, not eventually, high programming skills. The revenue is not at all negligible: the programmer is rewarded with significant visibility, becoming the target of important software companies, not mentioning the personal satisfaction and increase of confidence.*

*In this article, we try to focus on the main aspects of the competitive programming area, followed by a presentation of the most important competitive programming contests in the world. A distinct section is dedicated to fostering programming performance in Romania.*

**Keywords:** *competitive programming, algorithms, competitions*

## 1. Introduction

In the literature, Competitive programming is regarded as a mind sport, where the competitors, the programmers, are challenged to solve several programming problems, according to specifications. The problems are of algorithmic nature and usually the main challenge of the programmer is not only to find a solution for the problem in order to get the right answer, but, moreover, is to imagine a solution that will fit within the specifications, namely the time and memory limits.

This requires from the programmer, besides the high programming skills, a very good knowledge of algorithms, data structures and a good grasp of mathematical

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instruments. And not forget about the knowledge of a bunch of tips and tricks very useful in contests. In competitive programming, solutions are "pushed" to their limits, when they are tested on large amount of data. In [5] it is specified that it is necessary to have not only programmers, "but also creative coders, who can dream up what it is that the programmers need to tell the computer to do. The hard part isn't the programming, but the mathematics underneath it."

Besides being a mind-sport, competitive programming is a launching pad for the professional career of the programmer: high scored competitors are very "visible" in the market, they are targeted by some of the top software companies in the world.

This is why, in the last years, an immense industry has raised around this domain, where organizations, associations, companies, educational institutions, and so many, invest in organizing and fostering this very modern and attractive segment of software development.

In this article, the authors tried to present the most important aspects of the competitive programming area. First, a presentation of the general aspects of such a contest is provided, then, in the second part of the paper, a list of competitions is brought into discussion. We start the presentation with some well-known international, multi-layered, contests: The International Collegiate Programming Contest (ICPC), The International Olympiad in Informatics (IOI) and The International Informatics Olympiad In Teams (IOIT). Then, we present some contest organised by companies, and we name here HackerRank' CodeSprints, Topcoder and Code Chefs initiatives, and the famous Facebook Hacker Cup and Google Gem rounds.

The last section is dedicated to Romania. Romanian programmers are renewed in the entire world, being noted through their performance at all the international competitions. But more often their preparation starts in Romania, where they get a good preparation in schools, having the chance to meet very dedicated teachers and by testing their virtues on dedicated websites, or in national competitions and various contests.

## 2. General aspects regarding the Competitive Programming

A programming competition is an organized competition that involves individual competitors, or teams of competitors, depending on the specific contest, who must solve a set of algorithmic problems in a specific amount of time.

**2.1. The contest.** The actual contest is held over the Internet or a local network, in online or onsite manners. The onsite contests are directed to specific competitors, such are students from a certain college, town, state. Online competitions are

usually more permissive in terms of the participants, usually they are held within the auspicious of an organization when the competitor must enroll.

Contest are generally organized in rounds. Points collected in rounds can be accumulated in the competitor' profile, especially in the case of web-sites competitions. Rankings in rounds can grant the qualification to the next round. There is no general rule, every competition has its own rules.

**2.2. The duration.** The duration of a contest differs from one competition to another, usually the duration is between 2 hours and 5 hours. For individual competitions the duration is usually 2 hours.

**2.3. The problems.** Competitors must solve a set of problems, in any order. Each problem has a score, in some competition all problems have the same score, in other competitions scores differ in concordance with their difficulty. The competitors must solve as many problems as they can in the limited time of the contest. They will be rewarded with scores depending on how their solutions passed the tests.

Moreover, problems in programming contests have a specific structure:

- The story: Problems begin with a story, meaning a translation of the problem statement in a narrative or tale which is more friendly presented. For instance, the statement of the problem is presented as "a country that has cities and roads …", and not as "let's consider a graph…". Of course, behind the nicely presented story there is a mathematical model that will substantiate the further solution;
- The requirement: is explicitly stated;
- Input, output: complete and unequivocally specifications about the input and the output: type of the I/O (standard I/O or text file) and content;
- Restrictions and specifications: usually data description and/or constrains (size, limits, so);
- Examples and explanation: often the problems are accompanied with one or more examples accompanied by some explanations;
- Time and memory limits: are clearly specified as well. This means that the solution must fit within the time and memory limits in order to be scored. Time limit is expressed in milliseconds and more often it is under 2 seconds. The memory limit could be, for instance 64Kb.

**2.4. Programming languages and solutions:** Most common programming languages used in contests are C++, Java, and Python. The solutions are implemented in a single source file. Usually, the file must not exceed 20 KB, but this is not a restriction because competitive programming is much more about the

idea, the algorithm, the structures, while coding rests in the second place, so the sources are usually short, they doesn't exceed 200 lines of code.

Compiling the solution: the automated testing application includes or call an external compiler in order to compile the competitors' solutions. If the compilation is successfully done, the testing stars. Otherwise, a Compile Error (CE) will be generated.

**2.5. Testing and scoring.** The solutions are tested automatically, using Unit Testing type applications.

Testing a solution consists in 3 criteria testing:
- Correctness, meaning that, for a certain input, the output of the solution corresponds with the expected output;
- Time limit, meaning that the answer was obtained within the time limit allowed for the specific problem;
- Memory limit, meaning that the answer was obtained within the memory limits allowed for the specific problem.
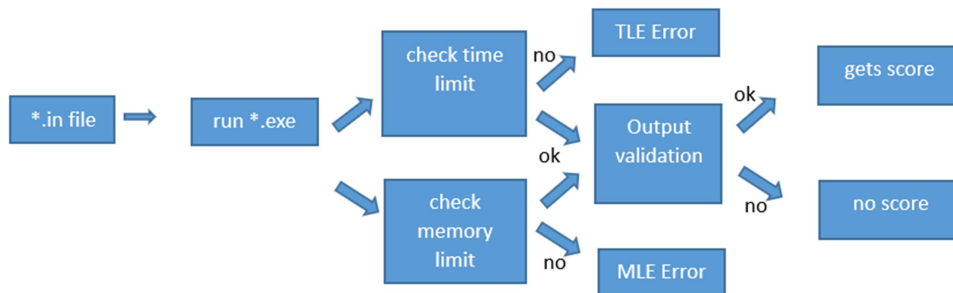


Figure 1. Single test flowchart

As the flowchart above shows, the solution complexity is very important in competitive programming, as well as in programming in general. It must fit within the time and memory limits, otherwise, even the output is correct, the test won't be scored. Unit testing applications records the status of the test, and if the solution didn't fulfill the requirements, an output will be given: TLE = Time Limit Exceeded or MLE = Memory Limit Exceeded or so.

Every solution is automatically tested against a certain number of tests. For instance, a problem can have 10 tests, every test consists in 2 kinds of files:
- *.in* file, where the input for that test is given;
- *.ok* file, where the expected output for that test is given.

So, there will be 10 *.in files (X1.in, X2.in, … , X10.in files, where X is the name or the id of the problem) and 10 *.ok files (X1.ok, X2.ok, … , X10.ok files).

The solution is run within the unit testing application, and for every test, its output, that could be an *.out file, is compared against the corresponding *.ok file. The degree of this correspondence can differ from one competition to another, in some competitions the expected file must be identical with the output file, in other competitions, partial scores are given for a partial correspondence. In order to get a correct evaluation, all tests are strictly formatted, and these formats are clearly specified in the statement of the problem, so the competitors can follow them. For instance, if an application asks for the minimum path in a graph, requiring its length and the lists of nodes, and the solution outputs correctly just the length, it can be partially scored, or not at all, depending on the rules of the competition.

In some competitions, tests are individual, meaning that a solution will score depending on how many tests it passes. In some other competitions, testes can be grouped, and a solution is scored only if it answered correctly to all tests in a group.

**Penalties.** Some competitions use a scoring system as a balance between the number of successfully tests and the productivity of the programmer: there is a penalty for how many incorrect attempts the competitor had during the contest. The penalty could also be related to the time of the submission of the successful solution.

Another form of inducing penalties consists in "hacking" other competitors' solutions. Any competitor can ask for access to the solution of an opponent, then try to deliver a test where the targeted solution will not work correctly. If he or she succeed, then the author of the hacked solution will lose points but will still have the chance to repair it. If the hacking attempt fails, the initiator will face some penalties.

**2.6. Evaluation:** evaluation differs from one contest to another, in some cases can be done during the contest, after submitting the solution, otherwise, the evaluation is done after the contest has finished. Nevertheless, the contestant is informed with the status of the tests, if the solution passed the test and it was scored (Accepted), or if the solution got an error such as: CE (compilation Error), TLE (Time Limit Exceed), MLE (Memory Limit Exceed), Runtime Error, Wrong Answer, so.

**2.7. Some aspects regarding the performance (complexity) of a solution:** In competitive programming, the performance of a solution is very tricky. The performance is measured as the solution's complexity, consisting in the execution time and the (extra)memory used. It is very well known that programming problems can accept more than one solution, but the choice of one or another strictly depends on the restrictions of the problem. In programming specific language, a brute-force solution is a solution that certainly solves the problem

(getting the right output), and sometimes it's easy to implement as well. But more often, the brute-solution doesn't fulfill the time and memory requirements, so a more sophisticated solution must be imagined.

**2.8. Code of behavior**. Most of programming competitions are online. This means that there is no control on who is the competitor and what he or she does during the competition. Therefore, competitors must conform to a code of conduct by which, during the contest, they cannot get help from outside, they cannot consult / use other people's sources and ask questions on forums or so.

**2.9. Some aspects regarding the 'Writing code for humans' principles:** In competitive programming, the sources are evaluated with automatic testing applications, so very often, competitors, especially the less experienced ones, don't give importance to the style of coding. But 'Writing code for humans', meaning respecting some code principles could be a good practice. It can help the competitor to organize better the flow of information through its code, which will prove an important asset in the maintenance and debug phase.

## 3. Competitive programming competitions

### 3.1. International competitions

#### 3.1.1. The International Collegiate Programming Contest (ICPC)

The International Collegiate Programming Contest (ICPC) is one of the oldest and most prestigious competitive programming competitions in the world. Its roots date back to the 70s. According to [6], "in 2018, ICPC participation included 52,709 students from 3,233 universities in 110 countries". Over several years, there had been a strong collaboration of ICPC with the Association for Computing Machinery (ACM), therefore sometimes the contest is referred to as ACM-ICPC.

The competition takes place every year among the universities of the world. ICPC is a team-based competition of 3+1 students (3 participants + 1 reserve) who are given 5 hours to solve between eight and fifteen programming problems.

ICPC is a multi-tiered competition, meaning that the contest consists in several rounds:

- ICPC - Regionals - are organized by the local universities. Sometimes they suppose multiple rounds in order to select the team that will represent the country at the World Finals. The onsite rounds are held the universities' premises, usually at the level of the university, followed by the sub-regional and then national level;

- World Finals – is the final competition that gathers the winners (one or more teams) from the Regional rounds.

The 2020 World Finals which were to take place in Moscow in June 2020, were postponed to May or June of 2021, due to the current pandemic situation [7].

The Top 5 ranking of teams at the ICPC World Finals in 2018 are presented in the table below:

| Rank | Institution | Country |
|------|-------------|---------|
| **1** | **Moscow State University** | **Russia** |
| **2** | **Moscow Institute of Physics and Technology** | **Russia** |
| **3** | **Peking University** | **China** |
| **4** | **The University of Tokyo** | **Japan** |
| **5** | **Seoul National University** | **South Korea** |

Table 1. The Top 5 teams ranking at the ICPC World Finals 2018 (adapted from [8])

The Romanian Collegiate Programming Contest 2019 took place on 28 of September 2019.

The ICPC Southeastern Europe Regional Contest gathers 101 teams of students from 55 Universities, from 8 countries (Bosnia And Herzegovina, Bulgaria, Cyprus, Greece, Macedonia, Romania, Ukraine, Serbia and Turkey) [9].

In 2019 has been organized as a multi-site contest: it took place on $19^{th}$ and $20^{th}$ of October in the same time in two universities: Politehnica University of Bucharest, Romania and Vinnytsia National Technical University, Ukraine. The Top 4 ranking is shown below:

| Place | Team | Institution | Country |
|-------|------|-------------|---------|
| 1 | Scrambled Eggs | University of Bucharest | Romania |
| 2 | KhNURE_NRG | Kharkiv National University of Radio Electronics | Ukraine |
| 3 | RAF Penguins | Faculty of Computer Science, Belgrade | Serbia |
| 4 | KhNU_DOROGA | V.N. Karazin Kharkiv National University | Ukraine |

Table 2. The Top 4 ranking at the ICPC Southeastern Europe Regional Contest in 2019 (adapted from [9])

### 3.1.2. The International Olympiad in Informatics (IOI)

The International Olympiad in Informatics (IOI) is a competitive programming competition for secondary school students. It is the most prestigious computer science competitions in the world. IOI takes place yearly under the auspices of United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Federation for Information Processing (IFIP).

IOI started in 1989 and in 2019 gathered 327 contestants from 87 countries [10]. The 2020 competition that was due to take place in Singapore, was postponed to an unspecified date.

The International Olympiad in Informatics is a multi-layered competition, it takes place at local level, regional, national and international levels. The national-level phases are organized through national organizations ending with the National Olympiad in Informatics. In Romania the national phases are: school level, town level (sector in Bucharest's case) and county. The Romanian national team counts about 20 high-school students, who compete in an extra competition in order to form the team for the international contest.

The national and international competitions are 2-days X 5 hours contests, where participants compete individually. For the IOI, there are at most four representatives of each country. The reward system is quite generous: 50% of the participants are granted with medals, the percentages are 1:2:3:6 for gold : silver : bronze : no medal.

The evaluation system has been changed in time: at first the sources were evaluated at the end of the competition, from 2010 there is a real-time evaluation but limited to the contestant (a participant can monitor his / her own results, not those of his or hers opponents). From 2012, a Contest Management System (CMS) is used for evaluation.

The 2019 Top 10 countries ranking at the International Olympiad in Informatics is presented below. Romania occupies an honorable position 6 cumulating over 100 medals, more than one third of them being gold medals.

| Rank | Nation | IOI Host | Gold | Silver | Bronze | Total |
|---|---|---|---|---|---|---|
| 1 | China | 2000 | 84 | 27 | 12 | 123 |
| 2 | Russia | 2016 | 62 | 38 | 12 | 112 |
| 3 | United States | 2003 | 52 | 35 | 16 | 103 |

| Rank | Nation | IOI Host | Gold | Silver | Bronze | Total |
|------|--------|----------|------|--------|--------|-------|
| 4 | South Korea | 2002 | 41 | 39 | 27 | 107 |
| 5 | Poland | 2005 | 40 | 41 | 31 | 112 |
| 6 | Romania | - | 30 | 50 | 31 | 111 |
| 7 | Bulgaria | 1989, 2009 | 27 | 43 | 38 | 108 |
| 8 | Iran | 2017 | 24 | 57 | 23 | 104 |
| 9 | Slovakia | - | 24 | 40 | 33 | 97 |
| 10 | Japan | 2018 | 23 | 24 | 10 | 57 |
| **Totals (10 nations)** | | | **407** | **394** | **233** | **1034** |

Table 3. The 2019 Top 10 countries ranking at the International Olympiad in Informatics  (adapted from [11])

Romania had the initiative of organizing a Central European Olympiad in Informatics (CEOI) and the first edition was held here in 1994, five years after the first IOI.

### 3.1.3. The International Informatics Olympiad In Teams (IOIT)

The International Informatics Olympiad In Teams (IOIT) is a 4+2 team competition. It was launched in 2017 at the initiative of the Aldini Valeriani Higher Education Institute from Bologna, Italy. The IOIT organization gathered several "Leader Schools" from different nations [12]. A Leader School is responsible with organizing the contests at national level. At national level, every school can participate.

In 2019 the organization had three members:

- Italy, represented by the Aldini Valeriani Higher Education Institute from Bologna
- Romania, represented by the National College of Informatics from Piatra Neamt;
- Russia, represented by the High School 1517 from Moscow

The Danderyds Gymnasium from Sweden is also in negotiations to join the IOIT community.

The competition includes 4 online national contests when all nations have the same problems in the same dates. The Leader School is responsible with the organization of these competition at national level. The teams consist in 4 students and up to 2 reserves from the same school.

### 3.2. Competitive programming challenges - support for business

### 3.2.1. HackerRank's CodeSprints

HackerRank is a tech company that focuses on competitive programming challenges in almost 15 core computer science domains, such are: algorithms (almost 40% of the contests) and functional programming, artificial intelligence, machine learning, datastructure, so, all other domains not exceeding 10% of the contests each.

The company addresses to both consumers and businesses. From consumer point of view, competitors are challenged in contests, referred as CodeSprints, where they accumulate scores based on which they are ranked globally on the HackerRank leaderboard. There are no restrictions on who can participate, as in ICPC's case, everybody can sign up and participate.

Although this is not the purpose of this article, we should mention the business dimension of the HackerRank company, who has released products such as: HackerRank for Work, CodePair, DroidRank, SudoRank, DbRank, products which have been received very well in the IT&C market as powerful instruments for recruiting personnel or for upscaling production through better productivity in programming domain.

A 2019 HackerRank Top 20 educational institutions have been published, an extras is available below. Romania occupies a leading position, being among the Top 20 HackerRank institutions:

| Rank | College | HackerRank Score | Country |
|------|---------|------------------|---------|
| 1 | ITMO University | 407.39 | Russia |
| 2 | Sun Yat-sen Memorial Secondary School | 387.18 | China |
| 3 | Ho Chi Minh City University of Science | 321.99 | Vietnam |
| 4 | UC Berkeley | 299.48 | United States |
| 5 | University of Waterloo | 266.59 | Canada |
| 6 | St. Petersburg State University | 260.68 | Russia |
| 7 | National Taras Shevchenko University of Kyiv | 255.83 | Ukraine |
| | …. | | |
| 19 | Babeș-Bolyai University | 153.72 | Romania |
| 20 | Grigore Moisil Gymnasium Satu Mare | 149.18 | Romania |

Table 4. A 2019 HackerRank ranking of educational institutions
(extras, adapted from [13])

The HackerRank company offers on its blog a compressive analysis of programming market. Here we find out that the Top 20 HackerRank ranking of countries that have the best programmers are (extras):

| Rank | Country | Score Index |
|------|---------|-------------|
| 1 | China | 100 |
| 2 | Russia | 99.9 |
| 3 | Poland | 98 |
| 4 | Switzerland | 97.9 |
| 5 | Hungary | 93.9 |
| …. | | |
| 20 | Romania | 81.9 |

Table 5. Top 20 HackerRank ranking of countries that have the best programmers, in 2019 (extras, adapted from [13])

### 3.2.2. Topcoder

Topcoder is a tech company founded in 2001 in US that offers outsourcing technology services. From its foundation, it organizes important competitive programming contests. The Single Round Matches (SRMs) is a 1.5-hour online competition consisting in three phases:
- the Coding Phase – this is a 75 min phase where the competitor is faced to three tasks having three levels of complexity and, accordingly, three levels of points.
- the Challenge Phase - is a 15 min phase of "hacking" other competitors' solutions.
- the System Testing Phase – consist in (re)evaluating the solutions targeted by a hacking attach: if the attach is successful, meaning that the targeted solution failed to a certain input, then all solutions will be retested with this new input. Scores will be reevaluated accordingly.

There is also a Topcoder Open Marathon Competition, a long term contest that consists in three online stages followed by the onsite Topcoder Open Finals that will take place in the US.

### 3.2.3. CodeChef

CodeChef is a competitive programming website launched in 2009 as a non-profit educational initiative of Directi, an Indian software company. The website hosts several competitions with monthly frequencies [19]:

- the Long Challenge - a 10-days contest with several questions of different difficulties;
- the Lunchtime - a 3-hour contest that takes place once a month; it features 4 questions;
- the Cook-Off - a 3-hour contest that takes place once a month; it features 5 questions.

### 3.3. Competitive programming competitions organized by tech companies

There are important technology companies that organize their own competitive programming competitions. Facebook organizes yearly, starting from 2011, the Facebook Hacker Cup, which is a worldwide programming competition.

Google hosts some of the most important competitive programming competitions that are organized directly by a company: CodeJam, Hash Code and Kick Start which take place every year in several rounds. Also, until 2018, the Distributed Code Jam took place.

Code Jam is a global coding competition for individuals. The competition has four online rounds and the onsite Code Jam World Finals, hosted at different international Google offices each year. Code Jam was launched in 2003 and, in the early years, has been hosted on the Topcoder platform. From 2008, Google uses its own platform for competitions.

A particularity of the Code Jam contest is that there are rounds when the competitors don't send their codes to Google to run them, but the competitors run their codes locally using the testing inputs sent by Google, and they have to answer with the correct output in a short limit of time. So, there is no code evaluation, but output evaluation. Only in the final rounds of Code Jam the participants have to upload their solutions to be evaluated by Google through a distributed environment.

Hash Code is another programming contest organized by Google. Hash Code is a team contest oriented towards students and professionals around the world and it covers the software engineering domain. It has two rounds: The Online Qualification Round and The Final Round, an onsite round hosted at a Google office.

Kick Start is a global online coding competition. The 3-hours rounds are online and are held throughout the year.

Regarding the rankings, at the Google Code Jam 2020, the last round took place in April 2020 (Round 1A), where there have been 1.193.000 participants, most of them from India (39%), United States (~10%) and China (7%). Three of the 75 programmers from Romania got the maximum score.

### 3.4. Competitive programming contests hosted by websites

**Codeforces**

Codeforces is one of the most powerful websites that host competitive programming contests. It was launched in 2009 and in 2010 it hosted its first contest. It was created at the initiative of a group of competitive programmers from the Information Technologies, Mechanics and Optics (ITMO) University in Saint Petersburg. After 10 years of activity, Codeforces has over 60.000 active contestants and over 75.000 registered users; in the last year "an increase was obtained in all major metrics (from 15% to 45%)" [14].

The figure below shows the evolution of the Active contestants on Codeforces website in the 10 years of activity:
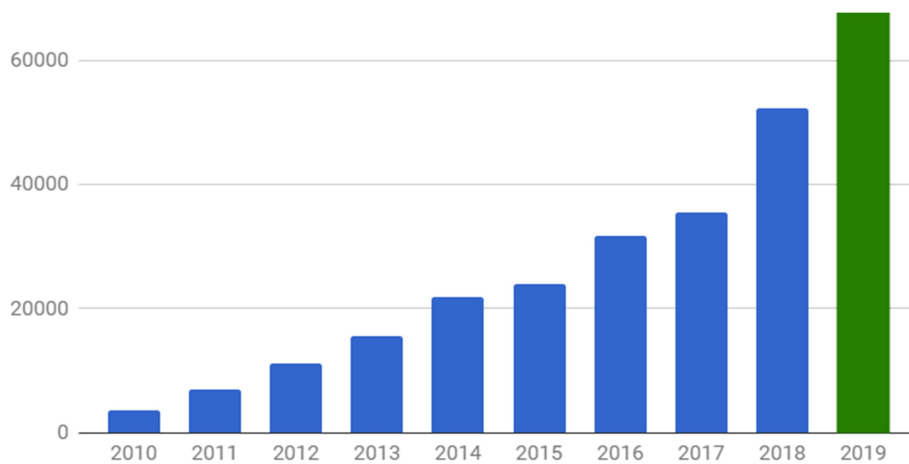


Figure 2. Evolution of the Active contestants on Codeforces website
in the 10 years of activity (source [14])

Codeforces offers weekly short rounds of 2-hours, or longer Educational contests several times a month. Codeforces contests implement the hacking system: competitors can "hack" opponents' solutions, thus getting ranking advantages.

Romania occupies a good position in the global rankings of Codeforces: there are over 1.000 Romanian competitors: 5 of them are GrandMasters, with rankings over 2.400, and 29 are classified as Masters or International Masters, having rankings between 2.099 - 2.399.

## 4. Competitive programming in Romania

In this section we try to make a characterization of the possibilities of performing competitive programming in Romania. It is not an exhaustive presentation, but a starting point in the knowledge of the domain.

### 4.1. Infoarena website

Infoarena is one of the most powerful Romanian websites that hosts competitive programming contests. The Website was launched in 2003, at the initiative of a small group of IOI Romanian gold winners [15]. The Infoarena.ro platform is a powerful tool for learning algorithms and computer programming and it hosts competitions like: Algoritmiada, Junior Challenge, Summer Challenge, FMI No Stress and so many others.

### 4.2. Competitions organized by educational institutions

In Romania, colleges and universities are strong players in organizing competitions addressed to both students and middle or high-school students. Among these contests, we notice:

"**EmpowerSoft**" is a school competition organized by "Mihai Viteazul" National College from the municipality of Ploieşti. It is a yearly competition in its sixth edition, it was launched in 2015. It comprises several contests [16]:

- Programming;
- Educational software / utility software / mobile phone applications;
- Web-pages.

The programming competition is an online individual contest with different school-levels sections. The evaluation is performed using automated testing at the end of the contest. Scores are given for accuracy of the answers but uploading time could be an important asset in case of a tide break.

The National College of Informatics Piatra Neamt organizes the "**PROSOFT @ NT**" contest. In was launched in 2012, and now, at its nineth edition, it was attended by students from Bulgaria, Russia, Poland and from 11 Romanian

counties as well, with a total of 126 students who were enrolled in the individual test of the programming competition [17].

"Grigore Moisil" Theoretical High School of Informatics from Iaşi organizes two competitions:
- "**The Followers of Moisil**" contest for middle school grades 5-8 students;
- "**Moisil++**" contest for high school grades 9-12 students [18].

Important competitive programming contests are organized at university level as well.

The League of Students of the Faculty of Automation and Computers (LSAC) from the Technical University "Gheorghe Asachi" from Iasi organizes the "**IT Marathon**", with five sections:

- Web development
- Desktop applications
- Mobile apps
- Design
- Junior Dev

The Junior Dev is an 8-hours competitive programming challenge dedicated to high school students consisting in solving a series of algorithmic problems of various difficulties, which require a broader vision of the field.

The Romanian-American University from Bucharest has its second edition of a competitive programming contest. The challenge entitled **"RAU-Devhack"** was launched in 2019 with a larger contest that included [20]:
- a Senior section consisting in a 24-hours hackathon for students;
- a Junior section, dedicated to high-school students, which was a 5+1 hours onsite contest.

The Junior section included two phases:
- Programming (5 hours) - consisted in solving 5 problems;
- What is the output? - (1 hour) consisted in a 100 multiple-choices questions set, where the student had to answer how many he or she could.

The 2020 second edition of the contest for high-school students was renamed "**RAUCoder**" and, at least this year, taking into consideration the pandemic situation, will be an online contest that will take place at the end of May.

## 4. Conclusion

Competitive Programming is one of the most exciting sport of mind nowadays. It attracts programmers, more often young programmers, keened to put themselves to constant challenge, to test and prove their skills in a domain with infinite resources. Results are spectacular, communities are incentives, everybody has a place and a purpose. It is a win-win situation for everyone. It's like a game: you play once, you play twice, you learn, get experience, then the reward will come, you are scored, you get image, you keep growing.

It is a worthwhile experience that such contests can offer. That's why, we consider this paper to be a good starting point in the knowledge of the competitive programming domain.

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    (All online resources were retrieved in May 2020)

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